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A CONSTRUCTIVE CONTRIBUTION TO THE RESPONSIBLE DEVELOPMENT AND USE OF ENGINEERED NANOMATERIALS

nanoRISK

OPTIMIZING THE BENEFITS OF NANOTECHNOLOGY WHILE MINIMIZING AND CONTROLLING THE RISKS

Insider Report

New research by scientists at the University of Rochester is the first to consider the effects of nanoparticle penetration through normal and barrier defective skin using an in vivo model system.

SUNBURN INCREASES RISK OF NANOPARTICLE SKIN PENETRATION

In early August, Samuel S. Epstein, Professor Emeritus of Environmental and Occupational Medicine at the University of Illinois at Chicago School of Public Health and Chairman of the Cancer Prevention Coalition, published a commentary in which he argued that the U.S. Food and Drug Administration (FDA) has failed to properly regulate potentially dangerous sunscreens (see page 4).

In similar fashion, consumer and environmental advocacy groups like Friends of the Earth are calling for application of the Precautionary Principle to manufactured nanoparticles and other applications of nanotechnology. Here, the basic idea is that manufacturers should have to prove to regulators that their products are not harmful before the products are sold.

The way things stand now, nanotechnology products can be sold unlabeled and the FDA regulates sunscreens only based on their sun protection factor (SPF). Cosmetic manufacturers, of course, claim that their products, including nanoparticle-based sunscreens are harmless. Indeed, nobody has demonstrated that they are unsafe – but the opposite proof, that they are perfectly safe, is missing as well. This confusing situation is due to the incomplete scientific picture created by a lack of relevant research. For instance, the question of whether or not nanoparticles can penetrate the healthy stratum corneum skin barrier *in vivo* remains largely unanswered. Furthermore, no studies so far have examined the impact of ultraviolet (UV) radiation on nanoparticle skin penetration. Since sunscreen is often applied to sun damaged skin, such a real world scenario, as opposed to *in vitro* studies in a test-tube, could go a long way in confirming or allaying fears.

New research by scientists at the University of Rochester is the first to consider the effects of nanoparticle penetration through normal and barrier defective skin using an *in vivo* model system.

"Our work was motivated by the increasing occurrences of occupational and consumer nanoparticle skin exposures and the fact that *in vitro* studies suggest that nanoparticles including quantum dots can exhibit dose and time dependent cytotoxic effects" Dr. Lisa DeLouise explains. "In conducting this work we also hope to shed light on inconsistencies that exist in pre-existing literature with regard to nanoparticle skin penetration using *ex vivo* skin models."

DeLouise, an Assistant Professor in the Department of Dermatology and Biomedical Engineering at the University of Rochester's (UR) Medical Center, together with her colleagues Prof. Günter Oberdörster and Prof. Alice Pentland demonstrate the importance of skin condition to effect the penetration of quantum dot nanoparticles in an *in vivo* mouse model. They have published their findings in *Nano Letters* ("In Vivo Skin Penetration of Quantum Dot Nanoparticles in the Murine Model: The Effect of UVR").

The scientific core of the UR scientists' findings is that commercially available carboxyl-terminated quantum dot nanoparticles penetrate more readily through UV-damaged mouse skin than through undamaged skin.

"Understanding the mechanisms and extent to which nanomaterials can penetrate skin is essential for establishing exposure health and safety guidelines" says DeLouise. "Our work advances this field as it documents that the outside-in barrier defect following an acute UV exposure permits quantum dot penetration. We found that the accelerated epidermal proliferation and differentiation of UV-radiated skin repair response is insufficient to prevent thequantum dots from

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A new report published by the Food Safety Authority of Ireland (FSAI) on nanotechnology and its potential future applications in relation to food and food packaging makes a series of recommendations to ensure that consumers' safety is protected in relation to developments in this area.

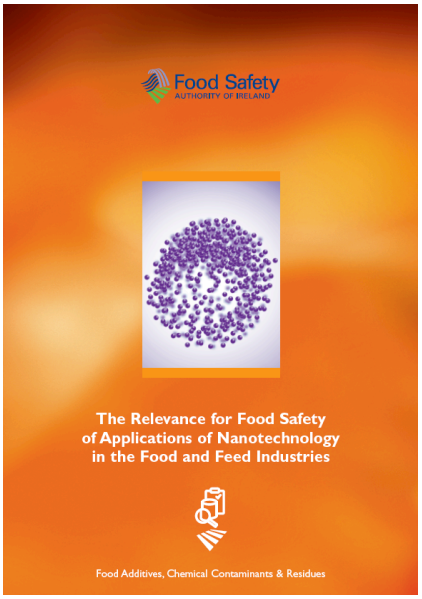
GOVERNMENT AUTHORITY URGES POLICY MEASURES FOR NANOTECHNOLOGY USE IN FOOD

"The Relevance for Food Safety of Applications of Nanotechnology in the Food and Feed Industries" outlines the current and potential uses of nanotechnology and the possible implications for the safety of food. It identifies potential benefits for both consumers and manufacturers from nanotechnology, which include extending the shelf-life of products, as well as enhancing taste and texture characteristics of food. However, it cautions that little is currently known about the possible effects in the food chain and there are recognised gaps in our knowledge base. There is therefore a need to ensure that regulatory (or legislative) controls are adequate to safeguard human health.

Nanotechnology is expected to offer immense potential for future product development and the FSAI states that whilst there are no foods currently on the Irish market that incorporate nanotechnology, policies should be devised now in advance of their arrival.

Call for EU Regulation

The report produced by the FSAI's Scientific Committee calls for an EU-wide centralised legislative framework to regulate the use of this technology in food and for food businesses to take primary responsibility for ensuring the safety of all foods produced with nanotechnology. In particular, it stresses the need for mandatory labelling of all food products or food packaging which employ nanotechnology, so that consumers can make informed purchasing decisions. In addition, when these products come on the Irish market, a national list of all products should be created, compiled and monitored by the FSAI. It suggests that research should urgently be undertaken to establish an assessment of possible risks in relation to nanotechnology in food.



According to the FSAI, there are significant advantages associated with the development of nanotechnology in food production, but as it is a relatively new process, its adoption by the food industry should be cautious.

"Benefits include masking of taste and odours, protection of ingredients during processing and digestions, and enhanced bioavailability. For example, nanoencapsulation of fish oils (omega 3 fatty acids) for use as ingredients in breads and other foods can mask the 'fishy' taste and improve shelf-life. In addition, nanotechnology has a role in development of "intelligent" food packaging that will provide a greater degree of traceability of products. For example, nano-structured metal films and coatings can strengthen bottles and other plastic wrapping material and incorporation of nanosenors into food packaging material will allow for the detection of contaminants such as harmful bacteria in foods and their surrounding environment," says Mr Alan Reilly, Deputy Chief Executive, FSAI.

Foods containing nano materials are available on the global market mainly through internet trading. Only a small number have been commercialized, mainly in countries outside the EU, although it is anticipated that this market will be worth approximately €15 billion by 2010. Regulatory controls on such products for personal use are recognised to be deficient and the FSAI and other food safety bodies in Europe do not have full enforcement powers in relation to them although EU legislation is being considered.

Mr Reilly, FSAI acknowledges that this is a novel and innovative development in food production and food packaging techniques and is certain to be an area of great potential for the food industry in the future.

Major Impact on Food Innovation

"Nanotechnology will have a major impact on food innovation over the coming decades, with many new applications foreseen in the agrifood sector for the benefit of consumers and the environment. That places a degree of urgency on having clear policies in place now before its widespread entry to the marketplace. While offering many benefits to manufacturers and consumers, the application of nanotechnology in the food industry may present new challenges in terms of safety and regulation to ensure that consumers are fully protected. Risk benefit analysis needs to be carried out and used to underpin food safety controls and the regulatory framework."

"Our role will be to assess each application of nanotechnology within food and food packaging on a case by case basis, until a standardised approach is developed within the EU for the assessment of the possible risks of nanoparticles", he concluded.

The FSAI would also like to see standardised risk assessments put in place across the board whereby food businesses employing this technology are obliged to conduct monitoring processes and should be held legally accountable on all stages of production.

A special open-access issue of Environmental Toxicology and Chemistry examines the issues surrounding toxicity of nanomaterials.

NANOMATERIALS - AN ENVIRONMENTAL PANDORA'S BOX?

Thanks to emerging technologies and other advances, nano-enabled products and materials are appearing more often in our environment. But these products may hold unknown risks for the ecosystems and the people who use them because of multilayered interactions involving nanotechnology and nanoparticles.

A special open-access issue of *Environmental Toxicology and Chemistry* examines these issues.

Colloidal nanoparticles in bulk form are used commercially as sunscreens, cosmetics, and protective coatings. Findings indicate that many nonparticles are not exceptionally toxic to standard test organisms, however additional research is needed to ensure appropriate methods are being used and the most highly exposed and sensitive organisms are being tested.

"Nanotechnology will be critical to solving global problems facing the environment and its inhabitants; however, the broad scope of the health and safety research as well as the pace at which data are needed to protect human health and the environment exceed current research efforts," writes Sally S. Tinkle in the introductory column for this special issue of *Environmental Toxicology and Chemistry*.

Articles in this special issue highlight these key findings:

- Nanoparticles can be toxic either due to metals associated with their structure or by themselves.
- Ingestion of nanoparticles by terrestrial insects can affect metabolic processes.
- Oxidative stress can affect fish health when antioxidant defenses are insufficient.
- Absorption onto algal cell walls can cause toxicity.
- Growth of some garden vegetables—for example, the tomato—can be affected while others—onion and cucumber—are not.
- Metals in quantum dots can be transferred to higher trophic levels.
- Different and possibly particle-specific approaches will be needed to fully determine environmental consequences.

Scientists and members of groups like the Society of Environmental Toxicology and Chemistry are working to develop methods and generate data that will allow for the evaluation of the risk of nanoparticles in the environment. With these evaluations, people will be able to enjoy the benefits of nanoparticles—in fields such as medicine, renewable energy, improved fuels and combustion, and other consumer products—while ensuring the compatibility of these technologies with the environment.

This special issue of Environmental Toxicology and Chemistry is the largest and most comprehensive set of nanotechnology papers to date.

Open access to the articles in this issue will be available for six months at the journals website at http://www.setacjournals.org/.

Environmental Toxicology and Chemistry is published by the Society of Environmental Toxicology and Chemistry. The journal is interdisciplinary in scope and integrates the fields of environmental toxicology; environmental, analytical, and molecular chemistry; ecology; physiology; biochemistry; microbiology; genetics; genomics; environmental engineering; chemical, environmental, and biological modeling; epidemiology; and earth sciences.

UPCOMING EVENTS
LOOKING AT THE RISKY SIDE OF NANO

Risk 2008
October 21-23, 2008, Paris (France)
The conference will address these three issues: What are the regulation policies? What about risk governance? What are the methodologies to estimate toxicity?

BioNanoTox
October 23-24, 2008, Little Rock, AK (USA)
BioNanoTox lies at the interface of a variety of disciplines ranging from biology to chemistry, toxicology, computational sciences, mathematics, engineering, nanotechnology and biotechnology.

Nanosafe 2008
November 3-7, 2008, Grenoble (France)
This conference is organised by the Integrated NANOSAFE2 project funded under FP6. The conference is intended to present, on the one hand, the main results issued from the project and, on the other hand, to make known the major progress and projections in the domain of the safe production and use of nanomaterials.

Environmental Nanoparticles: Science, Ethics, and Policy
November 10-11, 2008, Newark, DE (USA)
Major themes of the conference include human and environmental health, fate and transport, sensing and remediation, and future policy directions.

Nanotoxicology: Health & Environmental Impacts
February 27, 2009, Welwyn Garden City (UK)
This symposium is aimed at bringing together eminent scientists at the forefront of the nanotoxicology field to present their current research findings and discuss the potential impact of nanomaterials on human health and the environment.

SUNBURN INCREASES RISK…

Continued from page 1

breeching the skin barrier."

The researchers point out, though, that their results show that only a very minute amount of the applied quantum dots penetrate UV-compromised skin. It is conceivalble that a small number of penetrated nanoparticles could cause adverse effects depending on their composition, nanoparticle *in vivo* solubility and routes of excretion. For the case of titanium dioxide and zinc oxide used in sunscreens, adverse side effects have not yet been documented, says DeLouise. This is in contrast to existing literature results of high-dose *in vitro* studies on skin cells that observe cytotoxic reactive oxygen species (ROS) generation.

The researchers used quantum dots for their study because they enabled direct fluorescent imaging in skin. Quantum dots' efficient UV adsorbing and fluorescent properties has rapidly expanded their use in various biotechnology, military and security applications and they are being considered for use in cosmetic and UV blocking applications. Hence, it is imperative that these materials be designed to prevent skin penetration to avoid potential adverse health risk long term.

The goal of the UR scientists is to fully characterize the effect of nanoparticle surface chemistry and size on the mechanisms and extent of penetration.

"This knowledge will be used to rationally design nanoparticles to prevent or increase their penetration levels" explains DeLouise. "The ability to control nanoparticle penetration profiles will enable design of safe consumer products and will enable new biomedical technologies such as target nanoparticle therapeutic and diagnostic biomedical applications."

To this end, the researchers are working with a new class of quantum dots based on lead selenide in collaboration with the Krauss Group at UR. Recent results of this work have been published in *Nano Letters* as well ("Ultrabright PbSe Magic-sized Clusters").

A commentary by Samuel S. Epstein, M.D. Dr. Epstein is Professor Emeritus of Environmental & Occupational Medicine at the University of Illinois at Chicago School of Public Health and Chairman of Cancer Prevention Coalition.

FDA REMAINS ASLEEP AT THE WHEEL ON DANGERS OF SUNSCREENS

Since 1978, sunscreens have been regulated and labeled by the Food and Drug Administration (FDA) on the basis of their SPF (Skin Protection Factor). On August 23, 2007, the FDA proposed new regulations for more informative labeling of sunscreens. A year later, they still remain pending.

In response to FDA's inaction, and mounting concerns on the unreliability of the SPF, Connecticut Attorney General Richard Blumenthal wrote to the FDA on July 24 criticizing its failure to regulate the sunscreen industry, and prevent it from making "dangerously misleading claims" on the safety and effectiveness of its products.

A week later the "Sunscreen Labeling Act of 2008" was introduced. This gave the FDA six more months to finalize comprehensive rules, otherwise the Act would become law.

Sunscreens pose scientifically well-documented risks. While well known for over a decade, they remain unregulated by the FDA, and ignored by the industry.

Sunscreens are based on six ingredients, some of which actively penetrate the skin, accumulate in the body, and have been identified in urine and breast milk.

More ominously, these ingredients have toxic hormonal effects, known technically as "endocrine disruptive." Evidence for these effects has been well documented over the last decade. This includes stimulation of human breast cancer cells in test tube experiments, and increased uterine growth in immature female rats following skin painting or feeding.

Sunscreens block short wave ultraviolet light (UVB), which is responsible for sunburn. This encourages prolonged exposure, particularly of children. Moreover, sunscreens are ineffective against long wave ultraviolet light (UVA), which is responsible for malignant melanoma, the fastest growing known cancer. As a result, its incidence has increased by 130 percent, and its mortality has increased by 26 percent since 1975. FDA's continuing regulatory failure in this regard reflects the reckless indifference to consumer product safety of its Commissioner Dr. Andrew von Eschenbach, former director of the National Cancer Institute.

Of major concern, and still ignored by the FDA, is the increasing addition to sunscreens of unlabeled atom or molecule size zinc oxide or titanium dioxide particles. Technically known as nanoparticles, they increase the durability and effectiveness of these products. However, as reported in over two dozen scientific publications since 2003, including those by an Environmental Protection Agency research team and the International Center for Technology Assessment, nanoparticles can penetrate the skin, invade blood vessels, and produce devastating distant toxic effects.

FDA's regulatory failure extends from sunscreens to a wide range of other dangerous ingredients in cosmetics and personal care products. Of illustrative concern is FDA's reckless failure to respond to November 1994 and May 2008 Citizen Petitions, by the Cancer Prevention Coalition, "Seeking a Cancer Warning on Cosmetic Talc Products," used for feminine hygiene. As detailed in these Petitions, talc is a major avoidable cause of ovarian cancer, a relatively rare cancer at any age, whose incidence has escalated dramatically by 12 percent for white and 32 percent for black women, with about 15,000 deaths annually. This makes it the fourth most common fatal cancer after breast, colon and lung.

The "Sunscreen Labeling Act" should be the first step to developing a comprehensive "Cosmetics and Personal Care Products Labeling Act." This could be modeled along the lines of California's precedential 2007 Safe Cosmetics Act.

As warned by Senator Edward Kennedy at September 10, 1997 Hearings on the FDA Reform Bill, "The cosmetics industry has borrowed a page from the playbook of the tobacco industry by putting profits ahead of public health." This warning remains recklessly unheeded by the FDA.

The National Science Foundation (NSF) and the U.S. Environmental Protection Agency (EPA) have made awards to establish two Centers for the Environmental Implications of Nanotechnology (CEIN).

NSF AND EPA ESTABLISH TWO CENTERS FOR ENVIRONMENTAL IMPLICATIONS OF NANOTECHNOLOGY

The centers, led by UCLA and Duke University, will study how nanomaterials interact with the environment and with living systems, and will translate this knowledge into risk assessment and mitigation strategies useful in the development of nanotechnology.

"The new centers will provide national and international leadership in the emerging field of environmental nanoscience," said Arden L. Bement, Jr., NSF director. "This is an important addition to the National Nanotechnology Initiative, and builds on earlier discoveries on the environmental implications of nanotechnology made since 2001, when NSF's Center for Biological and Environmental Technologies was established. The new centers are aimed at strengthening our nation's commitment to research on the environmental, health and safety implications of nanomaterials."

The centers will work as a network, connected to other research organizations, industry and government agencies and will emphasize interdisciplinary research and education. Their challenge is to better integrate materials science and engineering with molecular, cellular, organismal and ecological biology and environmental science.

"The collaborative approach that these centers will use is key to quickly building the scientific foundation for understanding the health and environmental implications of nanomaterials," said George Gray, EPA assistant administrator for research and development. "This comprehensive research model promises to augment the knowledge we need to be good stewards of the environment."

Nanoparticles are as much as a million times smaller than the head of a pin, and have unusual properties compared with larger objects made from the same material. These unusual properties make nanomaterials attractive for use in everything from computer hard-drives to sunscreens, cosmetics and medical technologies.

With the rapid development of nanotechnology and its applications, a wide variety of nanomaterials are now used in clothing, electronic devices, cosmetics, pharmaceuticals and other biomedical products.

The potential interactions of nanomaterials with living systems and the environment have attracted increasing attention from the public as well as manufacturers of nanomaterial based products, academic researchers, and policy makers. Nanotechnology is expected to become a $1 trillion industry within the next decade.

However, the environmental implications of these materials are only beginning to be understood.

The UCLA CEIN, to be housed at the California NanoSystems Institute on the UCLA campus, will explore the impact of nanomaterials on the environment and on interactions with biological systems at all scales from cellular to ecosystem.

At the Duke University CEIN, researchers plan to define the relationship between a vast array of nanomaterials--from natural to man-made to incidental, byproduct nanoparticles--and their potential environmental exposure, biological effects and ecological consequences. Nanomaterials that are already in commercial use as well as several present in nature will be among the first materials studied.

"We are deeply committed to insuring that nanotechnology is introduced and implemented in a responsible and environmentally-compatible manner," said André Nel, Chief of the Division of NanoMedicine at UCLA, who will serve as the UCLA center's director. "We see the UC CEIN as providing an important service to our nation and beyond."

Traditional toxicity testing relies mainly on a complex set of whole-animal-based toxicity testing strategies. "This approach cannot handle the rapid pace at which nanotechnology-based enterprises are generating new materials and ideas," said Nel, who is also the Director of the UC led-Campus Nanotoxicology Research and Training Program at UCLA.

"The CEIN's development of a comprehensive computational risk ranking will allow powerful risk predictions to be made by and for the academic community, industry, the public, and regulating agencies."

At Duke University, "a distinctive element will be the synthesis of information about nanoparticles into a rigorous risk assessment framework, the results of which will be transferred to policy-makers and society at large," said Duke CEIN director Mark Wiesner, Professor of Civil and Environmental Engineering at Duke's Pratt School of Engineering. Wiesner specializes in nanoparticle movement and transformation in the environment.

The Duke research team brings together internationally recognized leaders in environmental toxicology and ecosystem biology; nanomaterial transport, transformation and fate in the environment; biogeochemistry of nanomaterials and incidental airborne particulates; nanomaterial chemistry and fabrication; and environmental risk assessment, modeling and decision sciences.

A major effort for the research team over the coming year is to develop 32 tightly instrumented ecosystems in the Duke Forest in Durham, N.C. Known as mesocosms, these living laboratories provide areas where researchers can add nanoparticles and study the resulting interactions and effects on plants, fish, bacteria and other elements.

"This mesocosm facility will be the nano-environment equivalent of the space station--a unique resource with tremendous potential that will be tapped by researchers throughout the center and beyond," said Wiesner.

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NSF AND EPA ESTABLISH TWO CENTERS…

"This research will address the influence of nanomaterials on processes ranging from the subcellular to whole ecosystems."

While UCLA serves as the lead campus for the UC CEIN, researchers from a range of other institutions and organizations are involved in UCLA CEIN research, including UC Santa Barbara (UCSB), UC Davis (UCD), UC Riverside (UCR), Columbia University (New York),University of Texas (El Paso, TX), Nanyang Technological University (NTU, Singapore), the Molecular Foundry at Lawrence Berkeley National Laboratory (LBNL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratory SNL), the University of Bremen (Germany), University College Dublin (UCD, Ireland) and the Universitat Rovira i Virgili (URV, Spain).

Duke CEIN deputy director Gregory Lowry from Carnegie Mellon University and co-principal investigator Kimberly Jones from Howard University specialize in nanoparticle movement and transformations in the environment. Mike Hochella, a nanogeochemist from Virginia Tech, and Rich Di Giulio, an ecotoxicologist from Duke are also co-principal investigators. Rounding out the team are collaborators Gordon Brown, a geochemist from Stanford University and Paul Bertsch, a soil scientist from the University of Kentucky.

Additional investigators affiliated with the Duke center include those at Clemson, and North Carolina State Universities, as well as scientists at the Environmental Protection Agency, Pacific Northwest National Laboratory, National Institute of Environmental Health Sciences, Army Corps of Engineers and the National Institute of Standards and Technology. International institutions collaborating with the Duke center include the European Center for Research and Education in Geosciences and the Environment; Sciences Po; Buenos Aires Institute of Technology; Nankai University; Swiss Federal Laboratories for Materials Testing and Research; Swiss Federal Institute of Aquatic Science and Technology; and the Institute of Occupational Medicine, United Kingdom.

The final report of the 4th NanoRegulation Conference held on from September 16-17, in St.Gallen, is now available online on the website of the Innovation Society.

THE PRECAUTIONANO PRINCIPLE - NANO REGULATION CONFERENCE REPORT PUBLISHED

The document gives an overview of the presentations, workshops and participants of this year's conference that focused on the topic of "Voluntary Measures in Nano Risk Governance".

From September 16-17, 2008, the 4th International NanoRegulation Conference took place in St.Gallen. During this event held in the context of the NanoEurope fairs, the participants and speakers discussed the latest developments in the area of voluntary measures in the field of nanotechnology risk governance.

The focus of interest was on three kinds of measures, namely codes of conduct, voluntary reporting schemes and systems for risk management (RMS).

At the outset, experts from the fields of insurance, regulation and international law highlighted the fundamental requirements on the design of such instruments and pointed out concrete examples. Furthermore, the participants gained an insight in the current state of the most discussed reporting schemes of Defra (UK) and the EPA (US). Representatives of different industries from producers to retailers presented their first experiences with voluntary measures in practice and showed the strengths and weaknesses of these instruments from a user perspective.

It became clear that the discussed measures are viable solutions for the current regulatory situation that can be characterised by uncertainty. However, it was also pointed out that the effectiveness of such measures needs to be continuously monitored in order to efficiently adapt them to the rapidly changing technology and market conditions. With the first certifiable risk management and monitoring system for nanotechnologies (CENARIOS®) the TÜV SÜD also presented a useful instrument for this purpose.

In the context of the second conference day, representatives of authorities from Germany, Austria and Switzerland presented the different approaches in their respective countries that are characterized by their strong national focus. In the subsequent workshops, questions of international collaboration, the effectiveness of different voluntary measures and the obstacles to overcome in the future were discussed.

It became apparent that not all instruments are equally suitable for different purposes. For example, the approach chosen in the area of public acceptance cannot be translated into the field of worker protection. Basically, the contribution of the measures to the building of trust among authorities, industry and the public was recognised. Voluntary measures will continue to play an increasingly important role in the future regulation of nanotechnology.

IN SHORT – PAPERS, INITIATIVES & UPDATES

PROJECT: New study tackles potential impact of inhaled nanometals

Three Johns Hopkins University researchers affiliated with the Institute for NanoBioTechnology hope to gain some insight on the health and environmental effects of nanoparticles by studying the ability of nanometals to access lung tissues, their potential to trigger pro-inflammatory reactions by cells that line the lung airways, and even the extent to which workers are exposed in a nanomaterials manufacturing setting. The National Science Foundation awarded nearly $400,000 to faculty members Shyam Biswal, Patrick Breysse, and Justin Hanes for their collaborative investigation on the toxic health effects of nanometal oxides.

PROJECT: NSF-funded risk study will trace path of nanomaterials

Led by Pedro Alvarez, the George R. Brown Professor and chair of the Civil and Environmental Engineering Department, and Vicki Colvin, the Pitzer-Schlumberger Professor of Chemistry and director of the Center for Biological and Environmental Nanotechnology, a NSF-funded study will trace tagged nanoparticles to increase understanding of how they move through the environment and what impact they may have on the health and function of natural systems. Fullerenes made with 14C, a mildly radioactive carbon isotope, were manufactured for the study. The tagged fullerenes can be tracked easily as they are altered by microbes, specifically fungi, and even monitored if they are completely broken down into carbon dioxide molecules.

PAPER: Aqueous adsorption phenols and anilines by a multiwalled carbon nanotube material

Knowledge of the adsorption behaviors of toxic chemicals by novel manufactured carbon nanotubes (CNTs) is critical for environmental application of CNTs as superior sorbents and for environmental risk assessment of both toxic chemicals and CNTs once they are released to the environment. The major goals of this study were as follows: (1) to study the influence of solution pH on the adsorption process, (2) to identify adsorption isotherms and the adsorption effects of the solute groups, and (3) to derive quantitative structureactivity relationships from adsorption isotherm parameters and solute physicochemical properties for the predicting of adsorptive behaviors. *DOI: 10.1021/es801463v*

PAPER: Computational and Ultrastructural Toxicology of a Nanoparticle, Quantum Dot 705, in Mice

Researchers conducted pharmacokinetic and toxicology studies on Quantum Dot 705 (QD705) in male ICR mice for up to 6 months after a single intravenous dose. Although histological alterations of the spleen, liver,andkidney by light microscopy are unremarkable, investigation using electron microscopy on numerous renal samples revealed definitive mitochondrial alterations in renal tubular epithelial cells at 28 days and 6 months postdosing. Health implications and potential beneficial applications of QD705 are suggested. *DOI: 10.1021/es800254a*

PAPER: What's new in Nanotoxicology? Brief review of the 2007 literature

This review covers research published in 2007 concerning toxicology of nanomaterials. Articles were selected from the Medline Pubmed database, published or pre-published during 2007, using keywords (nanomaterials or nanoparticles or nanostructures) and (toxicity or health). From the 238 articles, the authors chose to concentrate mainly on research into carbonaceous (carbon nanotubes [CNTs] and fullerenes) and metallic materials (pure metal, oxides), because of their relevance. *DOI: 10.1080/17435390802295737*

PAPER: Physicochemical Determinants of Multiwalled Carbon Nanotube Bacterial Cytotoxicity

This study compares the toxicity of commercially obtained multiwalled carbon nanotubes (MWNTs) before and after physicochemical modification via common purification and functionalization routes, including dry oxidation, acid treatment, functionalization, and annealing. Experimental results support a correlation between bacterial cytotoxicity and physicochemical properties that enhance MWNT-cell contact opportunities. For example, we observe higher toxicity when the nanotubes are uncapped, debundled, short, and dispersed in solution. These conclusions demonstrate that physicochemical modifications of MWNTs alter their cytotoxicity in bacterial systems and underline the need for careful documentation of physical and chemical characteristics when reporting the toxicity of carbon-based nanomaterials.
DOI: 10.1021/es8010173

PAPER: Fullerenes high potential to accumulate in living tissue

Research at Purdue University suggests synthetic carbon molecules called fullerenes, or buckyballs, have a high potential of being accumulated in animal tissue, but the molecules also appear to break down in sunlight, perhaps reducing their possible environmental dangers. Buckyballs may see widespread use in future products and applications, from drug-delivery vehicles for cancer therapy to ultrahard coatings and military armor, chemical sensors and hydrogen-storage technologies for batteries and automotive fuel cells. Findings indicated buckyballs have a greater chance of partitioning into fatty tissues than the banned pesticide DDT. However, while DDT is toxic to wildlife, buckyballs currently have no documented toxic effects. *DOI: 10.1021/es702809a*

PAPER: Intracellular uptake, trafficking and subcellular distribution of folate conjugated single walled carbon nanotubes within living cells

SWNTs were noncovalently functionalized with chitosan and then linked with folate acid and a fluorescence dye. The distribution of nanotubes inside cells demonstrated that they only locate in the cytoplasm and not in nuclei, indicating the failure of transporting through the nuclear envelope. No obvious cellular death rate was observed when the concentration of nanotubes was below 50 μg ml^{-1}. However, cells with nanotube uptake showed a concentration-dependent apoptosis. *DOI: 10.1088/0957-4484/19/37/375103*

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nano*RISK*

Nanowerk LLC
700 Bishop Street, Suite 1700
Honolulu, HI 96813, USA
Tel: +1 808 741-1739
Fax: +1 808 396-0493
E-mail: editor@nanorisk.org
Web: www.nanorisk.org

Optimizing The Benefits Of Nanotechnology While Minimizing And Controlling The Risks

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