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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

*Carbon nanotubes, when used at their doses and schedule, can cause reversible testis damage and reactive oxygen species generation without changing the hormonal levels, sperm health, and male mice fertility*

# THE IMPACT OF CARBON NANOTUBES ON MALE REPRODUCTIVE HEALTH

With fully conclusive findings about the toxicity of carbon nanotubes (CNTs) still up in the air, research on biomedical applications of CNTs is pushing full steam ahead. Adding to the list of potential concerns, a recent nanotoxicology study by a U.S.-Chinese research team looked into the impact of carbon nanotubes on male reproductive health.

The translocation and biodistribution of nanoparticles are key factors in their toxicity evaluation *in vivo*. Although other nanoparticles such as gold and magnetic nanoparticles have been reported to enter testes in small quantities, it had not been established whether CNTs could enter or accumulate in the testis.

"Our pilot study investigated the effects of intravenous injection of single and multiple doses of water-soluble multiwalled carbon nanotubes on the reproductive systems of male mice," says Bing Yan, Director, High-Throughput Analytical Chemistry Facility at St. Jude Children's Research Hospital in Memphis, TN. "Although our study showed that carbon nanotubes have minor effects on the male reproductive system in mice, oxidative stress and the alterations in the testes raise concerns because it is possible that these materials may accumulate at higher quantities over a longer period and may have adverse effects on male fertility."

Reporting their findings in *Nature Nanotechnology* ("Repeated administrations of carbon nanotubes in male mice cause reversible testis damage without affecting fertility"), Yan and his colleagues together with collaborators from Shadong University in Jinan, China, conclude that carbon nanotubes, when used at their doses and schedule, can cause reversible testis damage and reactive oxygen species (ROS) generation without changing the hormonal levels, sperm health, and male mice fertility.

To mimic the potential biomedical applications of the carbon nanotubes in terms of administration method and dose, the team intravenously injected the nanotube suspension through the tail vein into healthy adult male mice. The nanotubes were administered either as a single dose of 5 mg per kg or in five doses over 13 days at 5 mg per kg per dose. They then conducted reproductive toxicologic assessments on days 15, 60 and 90.

### Nanotubes show up in the testis

"Within 24 hours we found nanotubes in the testis, and accumulation resulted in oxidative stress and tissue damage" says Yan. "However, the damage was reversed after two months, and we observed no effects on mating, fertility, delivery or fetus viability under our experimental conditions. Sex hormones and sperm were unaffected by the nanotubes throughout the 90-day period, and treated mice continued mating with healthy female mice to produce healthy offspring."

Yan explains that the team examined the accumulation of 64Cu-labelled carboxylated carbon nanotubes in the testes after a single dose. What they found were approximately 41, 61 and 151 ng of nanotubes in the testes 10 minutes, 60 minutes and 24 hours after injection, respectively.

"Although the relative amount of nanotubes in the testes was small, the increasing trend suggests that with five repeated

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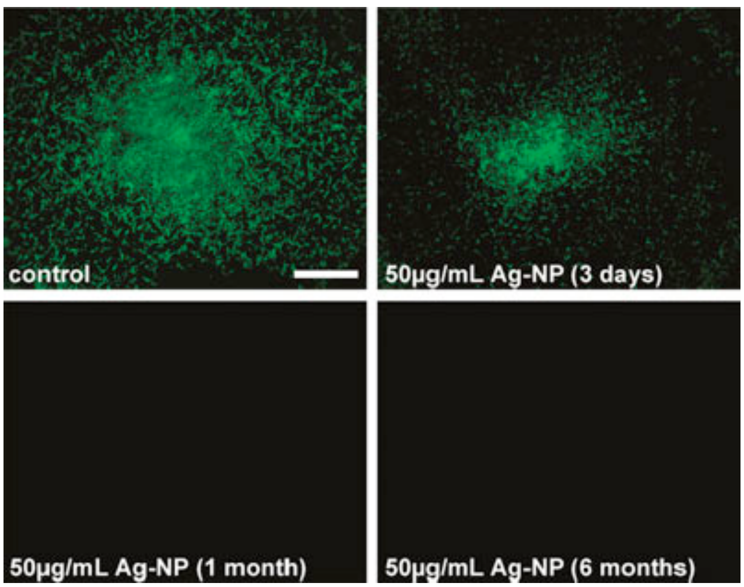
*A new report that shows that toxicity of silver nanoparticles increases during storage because of slow dissolution under release of silver ions*

# TOXICITY OF SILVER NANOPARTICLES INCREASES DURING STORAGE

Silver had already been recognized in ancient Greece and Rome for its infection-fighting properties but in modern times pharmaceutical companies made more money developing antibiotics. However, thanks to emerging nanotechnology applications, silver has made a comeback in the form of antimicrobial nanoparticle coatings for textiles, surgical instruments, lab equipment, floors or wall paints.

The flip side of silver's desired toxicity towards microbes is that it might have toxic effects for humans as well and this has raised debate about the safety of nanosilver products. Although scientists have worked to reduce the toxicity of antimicrobial nanosilver in products, concerns remain.

Not helping to put these concerns to rest is a new report that shows that toxicity of silver nanoparticles increases during storage because of slow dissolution under release of silver ions.




*Influence of added silver nanoparticles (Ag-NP) on the viability of human mesenchymal stem cells. Individual wells are shown. The cells were treated with 50 µg/mL silver nanoparticles of different ages for 24 hours under cell culture conditions. In the control, no silver was added. Viable cells are indicated by green fluorescence (calcein-AM staining). Scale bar: 2 mm.*

Led by Matthias Epple, a professor for inorganic chemistry at the University of Duisburg-Essen, the team prepared and characterized silver nanoparticles with different surface functionalization and studied their dissolution in ultrapure water at three different temperatures.

According to Epple, there is a general agreement that dissolved silver ions are responsible for the biological action that is especially pronounced against microorganisms. The lethal silver concentration of silver nanoparticles for human mesenchymal stem cells is about three times higher than that of silver ions (in terms of the absolute concentration of silver in a given solution).

The researchers note that only very little is known about the rate of dissolution of silver nanoparticles. "As this rate directly determines the concentration of silver ions in the vicinity of a nanoparticle, it is highly important for any antimicrobial application of silver nanoparticles, and also for assessment of the toxicity of silver nanoparticles in humans," they say. "In addition, the final fate of silver nanoparticles that are released into the environment (e.g., from silver-containing clothes into sewage plants) depends on these data."

It is likely that the rate of dissolution depends not only on the chemical species (i.e., 'metallic silver in nanoparticulate form') but also on the particle size, the surface functionalization, and the particle crystallinity. In addition, the temperature and the nature of the immersion medium (e.g., the presence of salts or biomolecules) will be major factors.

Epple's team found that the rate and degree of the dissolution of silver nanoparticles in water depend on their surface functional-ization, their concentration, and the temperature.

"In a given system under given conditions, a steady state was reached after several hours, i.e., the nanoparticles do not fully dissolve. This will change in a dynamic environment, e.g., during a perfusion experiment."

The researchers point out that such changes in the nanoparticle dispersions may escape the attention of the experimentalist because the classical analytical methods – e.g., dynamic light scattering, electron microscopy, or ultracentrifugation – are insensitive to released ions and because the particle diameter undergoes only a minor change. "A dynamic light scattering experiment of aged particles would typically be accepted as quality control that the particles did not change during storage, but this experiment would not reveal such dissolution phenomena".

With regard to the toxicity of nanoparticles in the body and in the environment, the biological action of freshly prepared and aged nanoparticles is strongly different due to the different amounts of released ions. Unfortunately, the dissolution in a biological medium is much more complicated to measure and describe because of the presence of various compounds in the medium, and the fate of the released silver ions is also unclear. Therefore, the dissolution in pure water, as in the experiments of the team, gives first indications on the fate of immersed silver nanoparticles in biological environments.

"Nevertheless, nanoparticles are typically not stored in biological media but in water before they are tested for their biological action, and therefore the reported results represent typical laboratory investigations of nanoparticle toxicity studies," writes Epple. "Some published discrepancies in reported toxicological levels may be explained by this fact. Of course, if nanoparticles are stored in the dry state, they will not dissolve, but this is not typical for surface functionalized, dispersible nanoparticles because of redispersion problems. 'Dry' silver nanoparticles that could be embedded in a matrix will also partially dissolve under release of silver ions when they come into contact with water, e.g., with washing water or with rain if applied outdoors."

# Safework Australia Publishes Reports On Nanomaterial Standards And Safety Issues

**New report on methods to reduce the risk of exposure to nanomaterials**:

Safe Work Australia commissioned RMIT to undertake a survey of the current substitution/modification practices used in Australian nanotechnology-related activities and a literature review in order to determine the potential substitution/ modification options that may reduce the toxicity of engineered nanomaterials used in Australia.

The document "Engineered Nanomaterials: Investigating substitution and modification options to reduce potential hazards" can be downloaded from the Safe Work website.

There are known methods that can be used to substitute/modify engineered nanomaterials that are used, or researched, in Australia. The methods of surface modification, encapsulation, particle size control, functional group addition and crystalline phase type control can each be employed for different engineered nanomaterials to decrease their potential toxicity. However in some cases, such modifications may affect the functionality of nanomaterials in relation to intended end-uses. If the researchers, developers and manufacturers of engineered nanomaterials adopt these methods then it is possible to re-engineer nanomaterials in the early stages of development to reduce the potential toxicity of manufactured nanomaterials. The downstream effect of this will be to reduce the risk posed by the use of these nanomaterials not only in the workplace but also in the general community.

**New report investigates feasibility of exposure standards for nanomaterials:**

The focus of the new report "Engineered Nanomaterials: Feasibility of establishing exposure standards and using control banding in Australia" is to investigate the feasibility of:

– establishing group-based Australian National Exposure Standards for engineered nanomaterials

– using control banding for engineered nanomaterials.

In December 2007, the British Standards Institution (BSI) published: "*Nanotechnologies – Part 2: Guide to safe handling and disposal of manufactured nanomaterials*" (the BSI Guide). The BSI Guide defines four hazard type groups for engineered nanomaterials, includes information on benchmark exposure levels (BELs) which are guidance on control levels for nanomaterials in those groups, and provides control guidance for those groups based on control banding. Investigating the feasibility of establishing group-based Australian National Exposure Standards and using control banding for engineered nanomaterials involved a detailed assessment of the groups, the BELs and the guidance based on control banding.

# Carnegie Mellon To Create New Program Of Study In Environmental Impact Of Nanotechnology

Researchers at Carnegie Mellon University and Howard University in Washington, D.C. have received $3.15 million over the next five years from the National Science Foundation (NSF) to launch a new interdisciplinary program in the environmental effects and policy implications of nanotechnology.

Funding comes from a new NSF program called the Integrative Graduate Education and Research Traineeship (IGERT), which enables creation of interdisciplinary programs educating U.S. Ph.D. scientists and engineers.

"The IGERT program at Carnegie Mellon and Howard will operate at the interface of science and environmental policy to produce an environmentally and policy literate generation of nanoscience professionals with the skills needed to create novel nanotechnologies and to assess and manage environmental risks associated with nanomaterials," said Jeanne M. VanBriesen, professor of civil and environmental engineering at Carnegie Mellon who will lead the program.

Graduate students from multiple disciplines will participate in a two-year-training program to learn the fundamentals of their core disciplines and gain proficiency in the analysis of environmental issues pertaining to nanotechnology, decision science, and policy-analysis in new nanotechnology-themed courses. Following this foundation, students will conduct research at the interface of policy and nanotechnology. Students also will participate in international laboratory exchange projects as well as internships at corporations active in nanotechnology.

VanBriesen will be joined in the program development and implementation by a cadre of professors including: Gregory Lowry, a professor in civil and environmental engineering at Carnegie Mellon and associate director of the Center for Environmental Implications of Nanotechnology CEINT; Elizabeth Casman, associate research professor for the department of engineering and public policy at Carnegie Mellon; and Kimberly L. Jones and Lorraine Fleming, both professors in civil and environmental engineering from Howard University.

Additional Carnegie Mellon faculty participants in this NSF-funded project include: Allen Robinson, a professor in the department of mechanical engineering; Kelvin Gregory, an assistant professor in civil and environmental engineering, Kris Dahl, assistant professor in the department of biomedical engineering and chemical engineering; Michael Bockstaller, an associate professor in the department of materials science, Mohammad Islam, an assistant professor in the departments of materials science and chemical engineering and Paul Fischbeck, a professor in the departments of social and decision sciences and engineering and public policy. Additional Howard University faculty participants include Gary Harris, a professor of electrical and computer engineering.

## Male Reproductive Health...

Continued from page 1

doses, more nanotubes would be expected to accumulate there" he says.

Yan points out that, after nanotube injection, throughout the entire experimental period, none of the mice from any group showed stress or symptoms of abnormality. But he notes that the accumulation of nanotubes in the testes raised the question of whether they could adversely affect Sertoli cells and seminiferous tubules. The testes from mice treated with five doses of carboxylated nanotubes were characterized by partially damaged seminiferous tubules, a significant reduction in the thickness of the germinative layer, and a reduction in the number of spermatogonia. Histologic studies also showed a partial disappearance or vacuolization of Sertoli cells.

"The initial histologic alterations and the increase in oxidative stress in the testes indicate that nanotubes may harm the male reproductive system" says Yan. "However, in a dosing schedule similar to typical biomedical applications, the extent of damage in the testes was much less than the damage caused by other toxicants."

This work by Yan and his collaborators systematically investigates male reproductivity toxicity of carbon nanotubes, broadens our understanding on the toxicological profiles of nanomaterials, and paves the way for the safe development of numerous medicinal applications of carbon nanotubes.

### Defining safe doses of carbon nanotubes in medicine

This work defines a possible range of safe doses if carbon nanotubes are to be used in medicine. Although carbon nanotubes induced initial pathologic alterations in the testes of mice, these alterations showed signs of recovery over time. The lack of adverse effects on the quality and quantity of the sperm further support this observation.

However, the results also indicate that higher doses or more repeated dosing schedules will likely cause severe damages in male reproductive systems.

"Considering the highly diverse structures and properties of nanomaterials and the multiple ways in which human exposure to nanomaterials can occur, further studies on the reproductive toxicity of nanomaterials, particularly following long-term and early life exposure, are urgently needed" concludes Yan.

He also points out that more work needs to be conducted in nano-reproductive toxicology. "The future directions for this field includes: 1) nano-female reproductive toxicological study; 2) nano-developmental toxicological study; 3) reproductive toxicology with long-term exposure; 4) reproductive toxicological study after early life exposure of nanomaterials" he says.

"The decline of human fertility is a result of very complicated and prolonged processes and complicated factors. As we are going into a society full of nanomaterials, how to mimic the real exposure of nanomaterials to human beings in the lab is key. Furthermore, how to evaluate the combined effects with other pollutants and factors and how to realize a quicker evaluation of nano-reproductive toxicity are all challenges facing our future research in this area."

## Assessing The Environmental Impact Of Organic Solar Cells

Solar energy could be a central alternative to petroleum-based energy production. However, current solar-cell technology often does not produce the same energy yield and is more expensive to mass-produce. In addition, information on the total effect of solar energy production on the environment is incomplete, experts say.

To better understand the energy and environmental benefits and detriments of solar power, a research team from Rochester Institute of Technology has conducted one of the first life-cycle assessments of organic solar cells. The study found that the embodied energy — or the total energy required to make a product — is less for organic solar cells compared with conventional inorganic devices.

"This analysis provides a comprehensive assessment of how much energy it takes to manufacture an organic solar cell, which has a significant impact on both the cost and environmental impact of the technology," says Brian Landi, assistant professor of chemical engineering at RIT and a faculty advisor on the project

"Organic solar cells are flexible and lightweight, and they have the promise of low-cost solution processing, which can have advantages for manufacturing over previous-generation technologies that primarily use inorganic semiconductor materials," adds Annick Anctil, lead researcher on the study and a fourth-year doctoral candidate in RIT's doctoral program in sustainability. "However, previous assessments of the energy and environmental impact of the technology have been incomplete and a broader analysis is needed to better evaluate the overall effect of production and use."

The study sought to calculate the total energy use and environmental impact of the material collection, fabrication, mass production and use of organic solar cells through a comprehensive life-cycle assessment of the technology.

According to Anctil, previous life-cycle assessments had not included a component-by-component breakdown of the individual materials present in an organic solar cell or a calculation of the total energy payback of the device, which is defined as the energy produced from its use versus the energy needed to manufacture the cell.

The team found that when compared to inorganic cells, the energy payback time for organic solar cells was lower. Ongoing studies to verify the device stability are still warranted, however.

"The data produced will help designers and potential manufacturers better assess how to use and improve the technology and analyze its feasibility versus other solar and alternative-energy technologies," adds Landi.

The team presented the results at the Institute for Electrical and Electronics Engineers 2010 Photovoltaic Specialists Conference. Anctil, who won a student award at the conference for best research, hopes to further analyze the environmental impacts of solar cell development with additional life-cycle assessments of other types of solar cell technology.

The study was funded through the United States Department of Energy and also included researchers from RIT's Golisano Institute for Sustainability and NanoPower Research Labs.

# NAUTILE: First Research Laboratory For The Study Of Carbon Nanotube Ecotoxicity In The Aquatic Environment

Arkema, CNRS, Institut National Polytechnique de Toulouse and Université Paul Sabatier have signed a framework agreement to set up a joint research laboratory, NAUTILE (NAnotUbes et écoToxIcoLogiE), the first public/private joint laboratory dedicated to the study of the ecotoxicological impact of carbon nanotubes (CNTs) in the aquatic environment.

Since committing in 2006 to manufacture CNTs at its Lacq research center, Arkema has always placed prevention, the control of risks, and the development of knowledge at the center of its concerns. préoccupations la protection de ses salariés, de ses clients et de l'environnement, en application du principe de précaution As regards the environment précisément, from the very beginning Arkema began to undertake fundamental studies jointly with Institut National Polytechnique de Toulouse (INPT) in order to better characterize any ecotoxicological impact that CNTs may have.

Arkema has now decided to boost this research by setting up with Toulouse CNRS, INPT and Université Paul Sabatier, the NAUTILE joint research laboratory, which will be dedicated to the study of multiwall CNTs in the aquatic environment. For CNRS, this agreement should enable new advances in CNT characterization through the pooling of the skills and expertise of its laboratories with Arkema's.

With their extensive field of applications and their outstanding properties, CNTs stand apart from the many categories of nanomaterials now available. Hence their potential effects on health and the environment represent an area of continuous investigation. This joint laboratory, drawing on the INPT, CNRS, and Université Paul Sabatier joint research units in collaboration with Arkema's own researchers, will be tasked with the development of experimental protocols and standardized methods for the study of the ecotoxicological properties of CNTs. It will therefore help develop knowledge of the potential impact of multiwall CNTs on aquatic species, at every stage of their lifecycle (development, production, use, and end-of-life of products featuring CNTs).

The NAUTILE program is one of the components of the GENESIS program, which is managed and run by Arkema at European level.

# NanoCode Project Publishes Synthesis Report On Responsible Development Of Nanotechnology

The NanoCode Project has recently published a Synthesis Report (pdf) that provides a broad overview of current codes of conduct, voluntary measures and practices aimed toward promoting responsible development of nanoscience and nanotechnologies (N&N), and which compares these with the provisions of the Code of Conduct (CoC) for N&N research as proposed by the European Commission. The report includes information drawn from individual country reports prepared by each of the NanoCode partners that covered the situation in their own country.

The NanoCode Synthesis Report is an invaluable resource for all those involved in promoting the responsible development of N&N and provides information also on the further initiatives to be taken in the NanoCode Project in developing tools to support the European CoC. Major conclusions of the report:

The information gathered in the Consortium Countries and in a number of countries outside it and summarized in this document, has confirmed that the responsible development of nanotechnologies represents a key topic in the agenda of all of them. The interest and the activity in this field, however, vary from country to country and this variability is somehow mirrored by a similar difference of the efforts with respect to governance and regulation. The overall situation can be roughly referred to two settings:

### Countries with a relevant activity in N&N

The majority of countries most active in nanotechnology, both in terms of industrial involvement and research, have specific national initiatives to support and promote their effort. Within this framework, the responsible development of nanotechnologies has gained an increasing attention and several initiatives to this end have been activated or are in the offing. Though often different from country to country in scopes and extent, the principles and the issues guiding these initiatives are generally common.

### Countries with a lower level of activity in N&N

In these countries national initiatives supporting N&N do not exist (or have been started only recently) and the activity in nanotechnologies is less structured and this applies also to the initiatives to address its responsible development. The importance of the issue is, however, well acknowledged and there are initiatives in this field particularly with respect to EHS issues. Normally for regulation, in the European countries the tendency is to look at the regulatory regimes coming from the European Commission. The activations of national initiative supporting N&N could modify the situation giving a boost both to R&D and regulation.

As for the European Commission Code of Conduct on nanotechnology research, it has been found that the EC CoC, whilst often known and sometimes discussed in stakeholders meetings, has not been yet formally adopted or implemented in the countries investigated, although it must be pointed out that its compliance is being made a mandatory condition for government funding in The Netherlands.

# Nanomanufacturing Center To Cooperate With Federal Health Agency On Nanotechnology Safety

Northeastern University's Center for High-rate Nanomanufacturing (CHN), a National Science Foundation-funded Nanoscale Science and Engineering Center, has signed an agreement with federal health researchers to advance research and guidance for occupational safety and health in nanotechnology.

According to the agreement, CHN at Northeastern University with its core partner institutions – the University of Massachusetts Lowell, and the University of New Hampshire – will collaborate with the National Institute for Occupational Safety and Health (NIOSH) to advance workplace health and safety standards and practices, and act as a global resource for research, education and information dissemination in nanotechnology safety and health.

The partners will pursue research on worker and consumer protection from exposures as well as on the toxicity of nanomaterials and their life cycle and environmental impacts.

"We're very happy about this partnership," said Ahmed Busnaina, CHN director and the William Lincoln Smith Professor of Mechanical and Industrial Engineering at Northeastern. "We need to make sure the process is safe and that we are protecting workers."

He said the agreement will lead to new research collaborations among its industry partners, and also builds on the strong interdisciplinary research in nanomedicine already taking place at Northeastern.

NIOSH Director John Howard visited Northeastern on Sept. 20 to sign the agreement, which he said is extremely important to advancing nanotechnology safety research, given the field's potential societal benefits.

The partnership advances Northeastern's mission to develop innovative, use-inspired research that solves global challenges in areas such as health, security and sustainability.

CHN's mission is four-fold: to bridge the gap between nanoscale science research and the creation of commercial products; to develop processes and tools that will enable high-rate/high-volume nanoscale manufacturing; to deliver educational information about nanomanufacturing to the workforce through partnerships among industry, universities and K-12 teachers and students; and to overcome barriers to commercialization.

**NanoSafe 2010**
*November 16-18, 2010, Grenoble (France)*
The objectives of the conference will be to make available the major progresses and future trends in the domain of the safe production and use of nanomaterials.

## Upcoming Events
### Looking At The Risky Side Of Nano

**Second Nanosafety Autumn School**
*October 4-8, 2010, Venice (Italy)*
The school will focus on emerging nanosafety aspects, concerning human and environmental exposure to engineered nanoparticles. The second cycle of the Nanosafety Autumn School will provide the update of the state-of-the-art on scientific knowledge and technical tools available for an integrated assessment of nanotechnology products.

**The Wider Context of Nanotechnology**
*October 11-December 3, 2010, online*
This course module will give an overview of the current state of the technology as well as sketching out the implications of these new technologies for safety, regulation, innovation and will give an overview of the societal and environmental implications.

**Nanotechnology VI Symposium: "Progress in Protection"**
*October 13, 2010, Los Angeles, CA (USA)*
This seminar builds on topics discussed at DTSC's previous nanotechnology symposiums. It also emphasizes occupational safety and health concepts, which are keys to reducing potential risks to workers and the environment from engineered nanomaterials.

**Nordic Tour 2010: Health Effects and Risks of Nanoparticles**
*October 27 – November 16, 2010, various locations*
The goal of this seminar series is to introduce the latest in nanotechnology to a wider audience and to discuss the possible health risks. Specialists in the area will gain from attending and hearing of the latest developments in the area. Each one-day seminar is comprised of morning sessions, which will be similar in each Nordic country.

**BioNanoTox and Applications Research Conference**
*November 4-5, 2010, 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.

**Seminar on Nanotechnology, Society and Environment**
*November 10-12, 2010, Rio de Janeiro (Brazil)*
The Seminar wants to be a space of exchange, to welcome and inform innovations and productions in the field of nanotechnology in health, while it will encourage the knowledge of their potential social, health and regulatory impacts.

**Benefits and Risk Communication for Nanomaterials**
*November 16, 2010, webinar*
Learn about the most current approaches to MSDS writing, control banding, and related business communication strategies to assist the occupational safety and health professional.

# In Short – Papers, Initiatives & Updates

### REPORT: Study looks at silver nanoparticle release from antibacterial fabrics into sweat

A recent study by researchers at National Nanotechnology Center (NANOTEC) in Thailand has provided the data on detecting silver released from antibacterial fabric products using artificial sweat as a model to represent the human skin environment. The researchers reported their work in a paper published by *Particle and Fibre Toxicology* ("Determination of silver nanoparticle release from antibacterial fabrics into artificial sweat"). Collaborators on this study included the faculty of Science at Srinakharinwirot University, Thailand.

### REGULATIONS: EPA issues significant new use rules under TSCA for carbon nanotubes

EPA is issuing significant new use rules (SNURs) under section 5(a)(2) of the Toxic Substances Control Act (TSCA) for two chemical substances which were the subject of Premanufacture Notices (PMNs). The two chemical substances are identified generically as multi-walled carbon nanotubes (MWCNT) (PMN P-08-177) and single-walled carbon nanotubes (SWCNT) (PMN P-08-328). This action requires persons who intend to manufacture, import, or process either of these two chemical substances for a use that is designated as a significant new use by this final rule to notify EPA at least 90 days before commencing that activity.

### PAPER: Agregation and deposition of engineered nanomaterials in aquatic environments: Role of physiochemical interactions

In this review, colloidal forces governing nanoparticle deposition and aggregation are outlined. Essential equations used to assess particle-particle and particle-surface interactions, along with Hamaker constants for specific nanoparticles and the attributes exclusive to nanoscale particle interactions, are described. Theoretical and experimental approaches for evaluating nanoparticle aggregation and deposition are presented, and the major findings of laboratory studies examining these processes are also summarized. Some of the challenges encountered when attempting to quantify the transport of nanoparticles in aquatic environments are described.
doi: 10.1021/es100598h

### STUDY: Centre for Food Safety conducts risk study on nanotechnology in food

The Centre for Food Safety (CFS) has recently conducted a risk assessment study in the form of a literature review on the potential safety issues associated with the application of nanotechnology in the food sector. In view of the accelerating development of nanotechnology in the food industry, the study aimed to review the basic principles, application and the potential health implications associated with the use of nanotechnology in the food sector, particularly on food and food contact materials incorporated with nanomaterials. While there is currently no internationally agreed definition for nanotechnology, it is usually applied to the process of controlling the size and shape of materials at the atomic and molecular scale.

### REPORT: New OECD report sums up current developments on nanomaterial safety

A new document from the OECD ("Current Developments/ Activities on the Safety of Manufactured Nanomaterials") provides information on current/planned activities related to the safety of manufactured nanomaterials in OECD member and non-member countries that attended at the 7th meeting of OECD's Working Party on Manufactured Nanomaterials (Paris France, 7-9 July 2010).

### PAPER: Uptake and release of double-walled carbon nanotubes by mammalian cells

The work in this paper demonstrates that under the experimental conditions of standard transfection methods, DWNTs are taken up by cultured cells but are then released after 24 h with no discernable stress response. The results support the potential therapeutic use of CNTs in many biomedical settings, such as cancer therapy.
doi: 10.1002/adfm.201000994

### REVIEW: Occupational exposure limits for nanomaterials: state of the art

The objective of this study is to investigate the transport of ultrafine particles (<100nm) into a residential building and to determine the functional dependence of infiltration on particle size and air change rate. Using continuous measurements of indoor and outdoor concentrations of size-resolved particles ranging from 5 to 100nm in a manufactured test house, particle penetration through the building, composite deposition, and the resulting value of the infiltration factor were calculated for two cases: closed windows and one window open.
Doi: 10.1007/s11051-010-0008-1

### REPORT: New report on engineered nanoparticle risk

IRSST, the Quebec-based *Institut de recherche Robert-Sauvé en santé et en sécurité du travail*, has released the second edition of its report "Engineered Nanoparticles: Current Knowledge about Occupational Health and Safety Risks and Prevention Measures". An initial review of the literature on nanoparticles prompted the IRSST to publish two reports on this subject early in 2006, namely on the health risks of nanotechnologies and on various aspects of industrial hygiene that involve them. Considering the rapid evolution in scientific knowledge, they have now released this update to the initial reports.

### PAPER: The role of surface functionality on acute cytotoxicity, ROS generation and DNA damage by cationic gold nanoparticles

Researchers have determined that both the acute cytotoxicity and genotoxicity of positively charged gold nanoparticles depend on the hydrophobicity of the ligands attached on their surface. Increasing the hydrophobicity of the particles increased their cytotoxicity. Interestingly, DNA damage *decreased* with increasing particle hydrophobicity.
doi: 10.1002/smll.201000463

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**Optimizing The Benefits Of Nanotechnology While Minimizing And Controlling The Risks**


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