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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

Scientists have begun to acknowledge that the identity of impurities and co-products during the synthesis of carbon nanotubes is critical to their toxicology and chemical behavior.

COMPARING APPLES WITH ORANGES – THE PROBLEM OF NANOTUBE RISK ASSESSMENT

Despite their name, carbon nanotubes (CNTs) are not made of 100% carbon. Depending on which of the various synthesis techniques is used in their production, CNTs have variable chemistries and physical properties resulting from their different metal catalysts or amorphous carbon coatings. As a result, they may contain large percentages of metal and carbonaceous impurities which will have different environmental and toxicological impacts. In early toxicological studies, researchers obtained confounding results - in some studies nanotubes were toxic; in others, they were not. The apparent contradictions were actually a result of the materials that the researchers were using, not appreciating that 'carbon nanotubes' are really 'carbon nanotubes + metal + amorphous impurities'. Ignoring these impurities prohibits scientists from fully understanding the material's electronic character, environmental transport, transformation, and ecotoxicology.

More recently, scientists have begun to acknowledge that the identity of these impurities and co-products is critical to CNTs' toxicology and chemical behavior. However, the chemical compositions of these fractions are not well defined and there have been no concerted efforts to identify and compile this information – without which accurate environmental risk assessments for specific CNT stocks is not possible.

Assessing Commercially Available CNTs In The U.S.

To address these needs, a group of researchers measured the elemental, molecular, and stable carbon isotope compositions of commercially available single-walled carbon nanotubes (SWCNTs) produced by ten companies in the United States, giving a true picture of their diversity and chemical complexity. This diversity and complexity is extremely important from both fate and toxicity perspectives.

Other CNT analytical methods can only be used with relatively pure samples, and current environmental techniques rely on electron microscopy – which is very tedious and time consuming – to detect CNTs.

"Our specific goals were to 1) identify metal catalysts and aromatic hydrocarbons that would be released with and affect the properties of SWCNTs, 2) seek compositional data suited to pursuing environmental exposure modeling of SWCNTs, and 3) find properties that would be helpful for detecting, and perhaps apportioning the sources of, SWCNTs in environmental matrices" says Desirée Plata. "If we are going to predict the toxicities of nanomaterials, we need to know what they contain and understand how those components vary – e.g., are they always 15% nickel and 5% yttrium? Do they all have hydrocarbon contaminants that may desorb in the environment?"

Plata, a joint program graduate student at MIT and the Woods Hole Oceanographic Institution (WHOI) and her mentors, chemists Phil Gschwend and Chris Reddy, found that the ten different carbon nanotubes had vastly different compositions. The scientists reported their results in the April 2, 2008 online edition of Nanotechnology (“*Industrially synthesized single-walled carbon nanotubes: compositional data for users, environmental risk assessments, and source apportionment*”).

This study is the first time that anyone has explored the use of carbon isotopes or metal ratios to track carbon nanotubes in the environment. Both of these analytical methods can be used to detect nanotubes in bulk samples (e.g., in sediments or

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The Investor Environmental Health Network reviewed SEC filings and analyzed 25 individual company annual reports to find that various companies have a very different attitude to communicating their use of nanomaterials.

COMPANIES FAIL TO APPRAISE INVESTORS OF POTENTIAL NANO RISKS

The Investor Environmental Health Network has released a report that demonstrates that sectors affected by product toxicity risks are doing a poor job of informing shareholders of market risks they face due to toxic chemicals in their products. The report specifically addresses the situation for companies dealing with nanomaterials by noting that manufacturers are not disclosing the evidence of health risks of nanotechnology products, nor the lack of adequate product testing prior to their sales.

An interesting observation is that some nanomaterial manufacturers are more open to communicating potential uncertainties than their customers. These customers of the nanomaterials are the manufacturers of an array of products from electronics to food and cosmetics - and they tend not to disclose the potential health and financial risks. IEHN's conclusion is that investors should be apprised of the state of the science by a company, instead of being misled to believe that the serious questions have been answered.

The Investor Environmental Health Network (IEHN) is a collaboration of investment managers with more than $41 billion in assets. For their report, titled "*Toxic Stock Syndrome: How Corporate Financial Reports Fail to Apprise Investors of the Risks of Product Recalls and Toxic Liabilities*" (pdf download, 1.7 MB), they reviewed thousands of SEC filings and analyzed 25 individual company annual reports for 2006 and 2007. Not limited to nanotechnology, the report examines disclosures on supply chain weaknesses before and after the 2007 toy recalls due to lead paint, on scientific studies showing products causing asthma, and on the new European chemical regulatory program, REACH (Registration, Evaluation, Authorization and Restriction of Chemicals).

In its section on nanotechnology and nanomaterials, the IEHN authors extensively quote from a widely circulated 2004 Swiss Re report "*Nanotechnology – Small matter, many unknowns*". One key quote addresses the fact that professional risk assessors already recognize the inherent danger in fast-emerging technologies such as nanotechnology, where risks and liabilities are not immediately apparent:

"Risks arising out of the introduction of new products or innovative technologies need not reveal themselves immediately and may occur after an interval of years. Nanotechnology is set to spread to such a wide range of industries and in such a large number of applications and at such speed, that the individual claims conceivable on the basis of experience and resulting from defects can hardly expect to be long delayed. Things will become critical if systemic defects only emerge over time, or if a systematic change in behavior remains undetected for a long time. In that case, an unforeseeably large loss potential could accumulate, for example, in the field of health impairment."

Confirming what we have written in the past here regarding certain industry sectors' (food, cosmetics), shall we say "reluctance" to share information about their products' nanomaterial ingredients, the authors write that "in general we observed that some of the specialists in the manufacture of nanotechnology products tended to engage in broader disclosure of potential health risks than those using nanotechnology as part of established consumer product lines."

Some companies address potential nanotechnology risks

The report specifically mentions nanomaterial and equipment manufacturers like Arrowhead Research Corporation, Luna Innovations, Nano-Proprietary Inc., and CVD Equipment Corp. as addressing potential health and safety concerns about their nanomaterials in their communication to the public.

Arrowhead is quoted as disclosing that "nanotechnology-enabled products, such as those used in our chemical detection technologies, are new and may be viewed as being harmful to human health or the environment...Because of the size, shape or composition of the nanostructures or because they may contain harmful elements, nanotechnology-enabled products could pose a safety risk to human health or the environment. The regulation and limitation of the kinds of materials used in or to develop nanotechnology enabled products, or the regulation of the products themselves, could harm the commercialization of nanotechnology-enabled products and impair our ability to achieve revenue from the license of nanotechnology applications." The firm also discusses health risk concerns surrounding nanotechnology, and how these could affect market value.

Luna Innovations acknowledges the limited safety record of nanomaterials, and foresees federal regulations surrounding nanotechnology. In an August 2007 quarterly report, the company states: "Our nanotechnology-enabled products are new and may be, or may be perceived as being, harmful to human health or the environment. While none of our current products are known by us to be hazardous or subject to environmental regulation, it is possible our current or future products, particularly carbon-based nanomaterials, may become subject to environmental regulation."

Nano-Proprietary Inc., a company that focuses on carbon nanotube applications, makes a similar prediction of future regulations on nanotechnology in its 2007 10-K: "Products using our technology will be subject to extensive government regulation in the United States and in other countries...We do not believe that carbon nanotube field emission products will present any significant occupational risks to the operators of such equipment...Nevertheless, OSHA, the EPA, the CDRH and other governmental agencies, both in the United States and in foreign countries, may adopt additional rules and regulations that may affect us and products using our technology."

IEHN quotes **CVD Equipment Corp**. as going the furthest of any company in acknowledging the concerns about its nanotubes products: "The health and environmental effects of nanotechnology are unknown, and this uncertainty could adversely affect the expansion of our business...There is no scientific agreement on the health effects of nanomaterials in general and carbon nanotubes, in particular, but some scientists believe that in some cases, nanomaterials may be hazardous to

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an individual's health or to the environment...Since part of our growth strategy is based on sales of research equipment for the production of carbon nanotubes and the sale of such materials, the determination that these materials are harmful could adversely affect the expansion of our business."

Some companies don't

The IEHN authors point out that carbon nanotubes are an example of a nanotechnology that may have some of the most serious risks, and manufacturers are making some vague references to potential health concerns and regulatory risks. In contrast "our review of SEC filings showed that the users who add these substances to their products are making few if any disclosures of the uses, the potential health risks based on their structures, and the financial risks to user companies."

NaturalNano Inc. is quoted as talking at length about its use of nanotubes technologies in health and beauty products and clothing, without flagging the health risk concerns relative to nanotubes.

Another example listed is **Procter & Gamble** whose website includes a discussion of nanotechnology in its research and development section. "The summary on the website focuses on the documented safety of ultrafine metal oxides used in sunscreens, implying that nanoscale products should be equally safe, although ultrafine particles are generally much larger than nanoscale particles. P&G concludes, 'With a long history of safe use in FDA-regulated products and a demonstrated lack of dermal absorption, there is extensive confirmatory evidence that nanoscale zinc oxide and titanium dioxide may be safely used in cosmetics and OTC drug products'."

IEHN writes that the cosmetics company **Avon** has made similar claims of product safety. In its spring 2008 statement in opposition to a shareholder resolution requesting a report on Avon's policies on nanomaterials product safety, the company broadly asserts in the proxy that these materials are safe. "Avon's evaluation included a specific assessment of the potential for nano-sized particles of these materials to be absorbed through the skin (several scientific studies have demonstrated that nano-sized titanium dioxide and zinc oxide do not penetrate the skin). In the opinion of Avon's scientists (toxicologists and other safety professionals) each of these materials can be used safely in cosmetic products."

IEHN says that neither Avon nor Procter & Gamble gives a balanced presentation of the scientific concerns about nanoparticles. "Some recent research on sunscreen ingredients in humans supports Avon's and Procter & Gamble's safety claim that the nanoparticles in sunscreen do not penetrate the skin, but others question whether testing is thorough enough to determine safety."

The report goes on to list several uncertainties concerning safety of the nanoparticles used in sunscreens and the

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UPCOMING EVENTS
LOOKING AT THE RISKY SIDE OF NANO

Environmental, Health and Safety Aspects of Nanotechnology: A Workshop for Reporters
July 20-22, 2008, Madison, WI (USA)
Journalists interested in exploring benefits and risks issues of nanotechnologies are invited to apply for this two-and-a-half day course.

Summerschool Ethics of Nanotechnologies
August 24-29, 2008, Enschede (The Netherlands)
The EthicSchool is open to young researchers from a wide variety of academic backgrounds. Participants will develop competence in ethical deliberations, enabling them to make useful contributions to responsible nanotechnology development, as stimulated by the European Commission's Code of Conduct, the Responsible NanoCode, and other initiatives.

Nanotoxicology – 2nd International Conference
September 7-9, 2008, Zurich (Switzerland)
This conference will bring you up to date with important research developments in nanotoxicological sciences.

Environmental Effects of Nanoparticles and Nanomaterials
September 15-16, 2008, Birmingham (UK)
While the production of nanomaterials is undergoing exponential growth, their biological effects and environmental fate and behaviour are relatively unknown. This meeting is the third international meeting on this topic.

Nanotechnologies at the OECD - 6th Session of the Intergovernmental Forum on Chemical Safety
September 15-19, 2008, Dakar (Senegal)
The Working Party on Manufactured Nanomaterials (WPMN) was established in 2006 by the Chemicals Committee. The objective of the WPMN is to promote international co-operation in human health and environmental safety related aspects of manufactured nanomaterials, in order to assist in the development of rigorous safety evaluation of nanomaterials.

4th International NanoRegulation Conference
September 16-17, 2008, St. Gallen (Switzerland)
The topic of this year's NanoRegulation Conference are voluntary measures in the identification, assessment, control and communication of nanotechnology risks (Nano Risk Governance).

Nanotech Northern Europe 2008
September 23-25, 2008, Copenhagen (Denmark)
One theme of the conference deals with "Safe Development of Nanotechnology". This track will cover the latest scientific research into the biological impact of engineered nanoparticles on the human body and the environment, in order to disseminate findings and to create cooperation and exchange in this field.

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aerosols), allowing for high-throughput quantification of carbon nanotubes in complex matrices.

The results show that the metals associated with carbon nanotubes are available for reactions with the outside world. "Many people suspected that they would not present a true danger, since they would not be free to react with or travel to the environment" says Plata. "Since that is not the case, we need to adjust the way we account for nanotube toxicity, reactivity, and potential environmental effects."

Metal Catalysts Might Prove Most Problematic

Plata and her collaborators think that the most concerning problem is the reactivity of the metal catalysts that travel with the CNTs. There are many approaches to try to minimize this effect, and probably the most effective approach, until we know more, will be to embed the materials inside of impermeable layers such as polymer matrices (which is used for instance in consumer products such as CNT-reinforced golf balls or tennis rackets).

"If a manufacturer chooses to use CNTs in clothes, sunscreens, water-filtration devices, or permeable reactive barriers (to treat ground water), they may be assuming an unintended risk to the public and the environment" says Plata.

This of course is the challenge that regulators are facing today: you can't regulate a toxin or tell if it is sitting in your backyard if you don't know how to find it in the first place or, even if you find it, don't know exactly what its effects are. Rather than modeling the risk of a generic, i.e., over-simplified, SWCNT, researchers need to develop nanomaterial risk assessment methods that take into account the actual diversity of these products and their interaction with the environment. This might lead to mathematical models relating certain CNT parameters to various degrees of toxicity.

Plata says that the research community is moving towards being able to track these diverse chemicals which will help to develop sound analytical techniques. This will also enable manufacturers to weigh the material-specific risk assessments and design synthetic processes to achieve environmental objectives while simultaneously considering performance and manufacturing cost.

Fingerprinting Carbon Nanotubes

An interesting side result from this research is that the unique metal ratios can be used to 'fingerprint' CNTs. The researchers note that, for example, in Houston there are several CNT manufacturers. If there were a release of CNTs to the environment, it would be possible to tell which manufacturer was responsible for the release based on the metal content of the nanotubes. The city of Houston could then identify a 'responsible party' and ask them to assist with the clean up.

The good news from research like this one of course is that it is taking place before a real problem pops up. This represents a big paradigm shift from the way some sectors of industry and society used (and use) to operate, i.e., pollute first, then worry about it later when it becomes a problem. If the emerging nanotechnology-based companies act responsible (and smart), they will fully embrace being asked challenging product safety questions and they will proactively support finding all the required scientific answers so that they can become an integral part during the design of new industrial processes and materials.

Plata says that, in a way, this is what environmental champions have been demanding since the 60s. "Rachel Carson wanted people to use DDT in a smart, indiscriminate way. She was against the ubiquitous distribution of poorly understood chemicals. Essentially, we're calling for the same type of action: use these chemicals, but use them in a smart way from start to finish. The old adage, 'it's easier to beg forgiveness than ask permission' doesn't apply to mother nature and it doesn't apply with public health. We need to be proactive about preventing future environmental catastrophes, and we have the means to do it."

In previous work (*Helping The Carbon Nanotube Industry Avoid Mega-Mistakes Of The Past*), Plata and colleagues found that the process of nanotube manufacturing produced emissions of at least 15 aromatic hydrocarbons, including four different kinds of toxic polycyclic aromatic hydrocarbons (PAHs) similar to those found in cigarette smoke and automobile tailpipe emissions. They also found that the process was largely inefficient: much of the raw carbon went unconsumed and was vented into the atmosphere. The researchers are currently working with materials scientists and industry to mitigate these effects.

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concludes: "Users of the sunscreen nanoparticles such as Avon and Procter & Gamble may be prematurely asserting safety, and neglecting to present a balanced picture of the limitations of testing conducted to date. Untested variables could influence the ability for nanoparticles to penetrate the skin or otherwise enter the body, including incidental consumption of the particles applied to the face, via the mouth."

The report concludes with recommendations to companies, investors, and the SEC, including the following:

- Companies should provide to shareholders additional information on chemical supply chain issues, including sources of materials, risk areas, and control systems.
- Investors should press for better disclosure from companies, through direct correspondence and support of shareholder resolutions seeking such disclosure.
- The SEC should issue new guidance to companies requiring them to more specifically report their product lines vulnerable to Europe's REACH regulation and should report more fully on credible adverse scientific findings that may impact the company.

A EU report concludes that conventional risk assessment methodologies may be adequate for products that contain soluble and/or biodegradable nanoparticles but not for insoluble and/or biopersistent nanoparticles.

EU Looks At The Safety Of Nanomaterials In Cosmetic Products

The controversy over the use of nanoparticles in everyday products, such as cosmetics, has been going on for a while now. At best, the evidence is inconclusive – it's too early to say whether there is a risk or not. The cosmetics industry of course argues that their nanoparticle-containing products are perfectly safe because no problem has been reported so far. Consumer, health and environmental groups beg to differ and claim that there is a potential risk because we just don't know enough about this issue and that we rather should err on the side of caution.

The fact is, as a recent report by the European Commission's Health and Consumer Protectorate states, that at present there is inadequate information on hazard identification, exposure assessment, uptake, the role of physico-chemical parameters of nanoparticles determining absorption and transport across membranes in the gut and lungs, the role of physico-chemical parameters of nanoparticles in systemic circulation determining biokinetics and accumulation in secondary target organs, possible health effects, and translocation of nanoparticles via the placenta to the foetus.

That's quite a long list of things we don't know about the fate of nanoparticles introduced into our bodies. The EU report concludes that conventional risk assessment methodologies may be adequate for products that contain soluble and/or biodegradable nanoparticles but not for insoluble and/or biopersistent nanoparticles.

Cosmetic products are primarily intended for use on skin, hair or in the mouth (toothpaste). These products may contain nanoparticulate matter, i.e. with dimensions below 100 nanometers. Cosmetics manufacturers claim that nanoparticles serve various purposes – they enhance the formulation properties and acceptability; have a direct effect on skin and hair, e.g. moisturizing or anti-aging formulations, make-ups and hair-conditioners; or protect the skin e.g. UV-filters in sunscreens.

A crucial factor in assessing possible risks associated with nanoparticles is their possible uptake, i.e. the entrance of a particular nanomaterial into the human body and what subsequently happens to it with regard to accumulation in organs, effects on metabolism, and excretion.

The EU's Scientific Committee on Consumer Products (SCCP) looked at the safety evaluation of nanomaterials for use in cosmetic products and considered the implications on animal testing and whether the previous opinions on nanomaterials currently used in sunscreen products would need to be revised. It reported its findings in March 2008 in a report titled "*The Safety of Nanomaterials in Cosmetic Products*" (pdf download, 492 KB).

The SCCP report differentiates between soluble and/or biodegradable nanoparticles which disintegrate upon application to skin into their molecular components (e.g. liposomes, microemulsions, nanoemulsions), and and insoluble and/or biopersistent particles (e.g. TiO_2, fullerenes, quantum dots).

It finds that for the former, conventional risk assessment methodologies based on mass metrics may be adequate, whereas for the insoluble particles other metrics, such as the number of particles, and their surface area as well as their distribution are also required.

It is crucial when assessing possible risks associated with nanoparticles to consider their uptake. While many uptake and translocation routes have been demonstrated, others are still hypothetical and need to be investigated. For topical applications, the route of exposure is essentially through the skin but exposure via inhalation, ingestion, conjunctival and mucosal surfaces may sometimes be relevant.

"It is primarily for the insoluble particles that health concerns related to possible uptake arise" the SCCP authors write. "Should they become systemically available, translocation/ transportation and eventual accumulation in secondary target organs may occur. This could become important with repeated application of cosmetic products. Inevitably, insoluble nanoparticles do represent a burden for the environment and a complete life cycle analysis is required."

The report's authors summarize the overall situation as follows: "At present, there is concern about insufficient information in the following areas:

- Hazard identification
- Exposure assessment
- Uptake (including physiologically compromised human skin)
- The role of physico-chemical parameters of nanoparticles determining absorption and transport across membranes in the gut and lungs
- The role of physico-chemical parameters of nanoparticles in systemic circulation determining biokinetics and accumulation in secondary target organs
- Possible health effects (including susceptible individuals)
- Translocation of nanoparticles via the placenta to the foetus."

The report takes a critical look at current testing practices and lists several areas of concern:

Especially relevant for cosmetic applications, the authors points out that in traditional risk assessment, skin penetration studies are carried out using healthy or intact skin. Possible enhanced uptake in case of impaired skin is considered to be covered in the Margin of Safety (MoS). "However, in the case of nanomaterials the conventional MoS may not give an adequate expression of the safety. If there is systemic absorption to vital tissues it may lead to rapid clearance from

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skin to systemic circulation. It may be anticipated that any systemic absorption is more likely to occur in conditions of abnormal skin e.g. sunburnt, atopic, eczematous, psoriatic skin. There is evidence that physical, in particular mechanical and/or chemical action on the skin may have an effect on nanoparticles penetration."

There are major data gaps in the assessment of the exposure and the uptake of nanoparticles via dermal absorption, inhalation, oral ingestion and eye contact. The reports looks at available scientific data for all these uptake routes. For instance for dermal exposure it describes the actual situation as follows:

1) There is evidence of some skin penetration into viable tissues (mainly into the stratum spinosum in the epidermal layer, but eventually also into the dermis) for very small particles (less than 10 nm), such as functionalized fullerenes and quantum dots.

2) When using accepted skin penetration protocols (intact skin), there is no conclusive evidence for skin penetration into viable tissue for particles of about 20 nm and larger primary particle size as used in sunscreens with physical UV-filters.

3) The above statements on skin penetration apply to healthy skin (human, porcine). There is an absence of appropriate information for skin with impaired barrier function, e.g. atopic skin or sunburned skin. A few data are available on psoriatic skin.

4) There is evidence that some mechanical effects (e.g. flexing) on skin may have an effect on nanoparticle penetration.

5) There is no information on the transadnexal penetration for particles under 20 nm. Nanoparticles of 20 nm and above penetrate deeply into hair follicles, but no penetration into viable tissue has been observed.

Although the basic requirements of testing the mutagenicity/genotoxicity of nanoparticles are similar to those of other particulate materials, the specific characteristics of nanoparticles may require further considerations. The present validated in vivo genotoxicity tests, however, do not cover the expected target organs of nanoparticles (particularly the respiratory tract) and have not been validated with reference substances including nanomaterials of relevance for cosmetics.

All *in vivo* and *in vitro* risk assessment methods for nanomaterials are still in the research phase. Although some validated in vitro methods do exist they have never been validated with nanomaterials as reference compounds.

Although animal testing can be largely reduced for skin penetration studies, they are essential for translocation and accumulation studies as well as for chronic toxicity studies.

The SCCP considers it necessary to review the safety of nanosized titanium dioxide in the light of recent information and to consider the influence of physiologically abnormal skin and the possible impact of mechanical action on skin penetration.

Activist groups point out that studies have questioned whether traditional assumptions about silver's safety are sufficient in light of the unique properties of nanoscale materials.

GROUP FILES LEGAL ACTION FOR EPA TO STOP SALE OF 200+ NANOSILVER PRODUCTS

On May 1, 2008, the International Center for Technology Assessment (CTA) and a coalition of consumer, health, and environmental groups filed a legal petition with the Environmental Protection Agency (EPA), demanding the agency use its pesticide regulation authority to stop the sale of numerous consumer products now using nano-sized versions of silver. The legal action is the first challenge to EPA's failure to regulate nanomaterials.

Increasingly manufacturers are infusing a large and diverse number of consumer products with nanoparticle silver ("nano-silver") for its enhanced "germ killing" abilities. Nano-silver is now the most common commercialized nanomaterial. CTA found over 260 nano-silver products currently on the market, ranging from household appliances and cleaners to clothing, cutlery, and children's toys to personal care products and coated electronics. Yet as CTA's legal petition addresses, the release of this unique substance may be highly destructive to natural environments and raises serious human health concerns.

"These nano-silver products now being illegally sold are pesticides," said George Kimbrell, CTA nanotech staff attorney. "Nano-silver is leeching into the environment, where it will have toxic effects on fish, other aquatic species and beneficial microorganisms. EPA must stop avoiding this problem and use its legal authority to fulfill its statutory duties."

The legal petition demands that the EPA regulate nano-silver as a unique pesticide that can cause new and serious impacts on the environment. The hundred-page petition calls on EPA to: regulate these nanotechnology products as new pesticides; require labeling of all products; assess health and safety data before permitting marketing; analyze the potential human health effects, particularly on children; and analyze the potential environmental impacts on ecosystems and endangered species.

Joining the CTA petition are: the Center for Food Safety, Beyond Pesticides, Friends of the Earth, Greenpeace, ETC Group, Center for Environmental Health, Silicon Valley Toxics Coalition, Institute for Agriculture and Trade Policy, Clean Production Action, Food and Water Watch, the Loka Institute, the Center for Study of Responsive Law, and Consumers Union.

In Short – Papers, Initiatives & Updates

PAPER: Studies have questioned whether traditional assumptions about silver's safety are sufficient in light of the unique properties of nano-scale materials?

A method to investigate the dependence of the physicochemical properties of nanoparticles (e.g., size, surface area and crystal phase) on their oxidant generating capacity is proposed and demonstrated for TiO_2 nanoparticles. For a fixed total surface area, an S-shaped curve for ROS generation per unit surface area was observed as a function of particle size. The paper discusses the implications of these ROS studies on biological and toxicological studies using nanomaterials.
DOI: 10.1080/17435390701882478

PAPER: Transport and retention of nanoscale C_{60} aggregates in water-saturated porous media

Experimental and mathematical modeling studies were performed to investigate the transport and retention of nanoscale fullerene aggregates (nC_{60}) in water-saturated porous media. Retention of nC_{60} in glass bead columns ranged from 8 to 49% of the introduced mass, while up to 77% of the mass was retained in Ottawa sand columns. These observations were consistent with independent batch retention data and theoretical calculations of electrostatic interactions between nC_{60} and the solid surfaces.
DOI: 10.1021/es800128m

PAPER: Manufactured nanoparticles: their uptake and effects on fish – a mechanistic analysis

There is an emerging literature reporting toxic effects of manufactured nanomaterials (NMs) and nanoparticles (NPs) in fish, but the mechanistic basis of both exposure and effect are poorly understood. This paper critically evaluates some of the founding assumptions in fish toxicology, and likely mechanisms of absorption, distribution, metabolism and excretion (ADME) of NPs in fish compared to other chemicals. Then, using a case study approach, the paper compares these assumptions for two different NPs; TiO_2 and C_{60} fullerenes. The paper identifies many knowledge gaps including the lack of field observations on fish and other wildlife species for exposure and effects of manufactured nanomaterials.
DOI: 10.1007/s10646-008-0205-1

PAPER: Carbon nanotubes that look like asbestos, behave like asbestos

A major study published in *Nature Nanotechnology* suggests some forms of carbon nanotubes – a poster child for the "nanotechnology revolution" – could be as harmful as asbestos if inhaled in sufficient quantities. The study used established methods to see if specific types of nanotubes have the potential to cause mesothelioma – a cancer of the lung lining that can take 30-40 years to appear following exposure. The results show that long, thin multi-walled carbon nanotubes that look like asbestos fibers, behave like asbestos fibers. There is a silver lining to this research: Short or curly carbon nanotubes did not behave like asbestos, and by knowing the possible dangers of long, thin carbon nanotubes, researchers can work to control them.
DOI: 10.1038/nnano.2008.111

INITIATIVE: No takers yet for EPA's in-depth Nanoscale Materials Stewardship Program

On January 28th, 2008, EPA launched the Nanoscale Materials Stewardship Program (NMSP). The NMSP was designed for companies that manufacture, import, process, or use nanoscale materials for commercial purposes to voluntarily submit data to EPA and also to participate in the development of additional data. To date EPA has received three submissions for nanoscale materials under the basic program. EPA has also received commitments from ten additional companies to submit data on nanoscale materials under the basic program. The participants list is attached below.

Thus far no one has signed up to participate in the in-depth portion of the NMSP. EPA would like to initiate discussions regarding testing of nanoscale materials under the in-depth program. The agency encourages anyone interested in starting this dialogue to contact EPA as described on the TSCA nanotechnology webpage. The webpage also includes details on the NMSP including how to participate in the basic program.

SURVEY: Corporate nanotechnology survey in Germany explores exposure to nanomaterials

Results of a corporate survey by the Federal Institute for Occupational Health and Safety (BAuA) and the Association of the Chemical Industry (VCI) in Germany have been published on BAuA's website: Exposure to nanomaterials in Germany (pdf download, 237 KB). This survey is a first step in Germany to gain an overview of the production, use and handling of synthetic nanomaterials. Based on these findings, new focus areas and need for action can be identified.

PAPER: How buckyballs hurt cells

A new study into the potential health hazards of fullerenes predicts that the molecules are easily absorbed into animal cells, providing a possible explanation for how the molecules could be toxic to humans and other organisms. Using computer simulations, University of Calgary biochemist Peter Tieleman, post-doctoral fellow Luca Monticelli and colleagues modeled the interaction between carbon-60 molecules and cell membranes and found that the particles are able to enter cells by permeating their membranes without causing mechanical damage.
DOI: 10.1038/nnano.2008.130

PAPER: The ecotoxicology of nanoparticles and nanomaterials: current status, knowledge gaps, challenges, and future needs

This paper introduces a special issue on the ecotoxicology and environmental chemistry of nanoparticles and nanomaterials in the journal *Ecotoxicology*. The main conclusion is that there are many challenges ahead, and controversies (e.g., reference substances for ecotoxicology), but knowledge transfer from mammalian toxicology, colloid chemistry, as well as material and geological sciences, will enable ecotoxicology studies to move forward in this new multi-disciplinary field.
DOI: 10.1007/s10646-008-0206-0

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OPTIMIZING THE BENEFITS OF NANOTECHNOLOGY WHILE MINIMIZING AND CONTROLLING THE RISKS

The nano*RISK* newsletter is dedicated to providing objective and accurate information about critical issues and developments related to the risks arising from engineered nanomaterials. nano*RISK* appears bi-monthly. ISSN 1931-6941. A compilation of weblinks relevant to this edition of the newsletter can be found on www.nanorisk.org.

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