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Recent Government Briefs

(Berkeley, CA, City Council) The Berkeley California City Council voted on Tuesday, December 12, to amend its hazardous materials law to require researchers and manufacturers to disclose their use and/or manufacture of nanoparticles. Targeting nanotechnology start-ups and small businesses, the City Council's precedent-setting ordinance regarding manufactured nanoparticle health and safety disclosure will require information to be provided to the Council on the current toxicology of used/manufactured nanoparticles, as well as on actions to safely handle, monitor, contain, dispose, track inventory, prevent releases, and mitigate such materials. With this action, Berkeley is being described as the first US city to regulate nanotechnology. For more information, visit: <http://www.ci.berkeley.ca.us/citycouncil/>

(US EPA) In late November, the US EPA reversed a prior decision and announced their intention to regulate products that claim to kill germs through the release of nanosilver or other related technologies under the Federal Insecticide, Fungicide & Rodenticide Act (FIFRA). With final rules to be provided in the Federal Register in the next few months, manufacturers advertising their nanosilver products as "germ killing" will be required to provide scientific evidence that these products do not pose an environmental risk. Nano-sized silver particles are currently marketed for their germ-killing capabilities in a variety of products including shoe liners, food-storage containers, air fresheners, and washing machines. US EPA had previously labeled products such as Samsung's SilverCare washing machine, which generates nanosilver ions to kill odor-causing bacteria and sanitize clothes, as pesticidal "devices" that were exempt from regulatory review under FIFRA. With this reversal of its prior determination, US EPA is now characterizing nanosilver as a pesticide rather than as a device, resulting in one of the first agency regulatory actions pertaining to nanoparticles.

Reports, Reviews, White Papers, and Books

Insights Into the Health Effects of Nanoparticles: Why Numbers Matter

http://www.ciit.org/news_events/pdfs/CIIT_Activities_May-Sept_2006.pdf

In this review of work done at CIIT, Dr. Moss explains how both nanoparticle surface area and number can affect alveolar macrophage function. CIIT researchers hypothesized that the more nanoparticles a macrophage is exposed to, the more the surface area of that cell is "shielded" from other particles or molecules. Using this new approach to interpreting macrophage-mediated clearance, they reevaluated work by Oberdörster et al. (1994) and confirmed their findings of the significance of both nanoparticles number and surface area via confocal laser scanning microscopy. Dr. Moss concludes that this work can be used in in vitro and in vivo experiments for risk assessments of nanoparticles. In particular, by facilitating improved dose extrapolations, this approach will allow for more realistic predictions of nanomaterial risks.

Current Practices for Working With Nanomaterials:

Phase 1: Current Knowledge and Practices Regarding Environmental Health and Safety in the Nanotechnology Workplace

Phase 2: Survey of Current Practices in the Nanotechnology Workplace

Prepared by the University of California at Santa Barbara for ICON

http://icon.rice.edu/projects.cfm?doc_id=4388

A year ago, the International Council on Nanotechnology (ICON) identified the lack of "a consolidated understanding" of current EH&S and stewardship practices in nanomaterial manufacturing and called for proposals for the performance of a survey of current workplace practices. As a result, ICON recently published a two-phase report on practices in the nanotech workplace. The work for both reports was conducted by an interdisciplinary team of researchers at UC Santa Barbara and was sponsored by ICON. In the phase I report, the aim was to document, review, and evaluate current practices, particularly in North America, the EU, Asia, and Australia, and to recommend "best practices" and risk assessment frameworks. The phase II report presents results of an international survey completed by 64 companies and labs (academic and industry) in nanotech. The questionnaire covered topics such as EH&S training, the use of personal protective equipment, and risk characterization. These two reports provide a comprehensive—and important—view of the current state of nano workplaces, and what is lacking in the field.

Upcoming Meetings and Conferences

NanoTech Insight

March 10-17, 2007; Luxor, Egypt

<http://www.nanoinsight.net/in/07/view/index/index.cfm>

With reports on cutting edge developments in nanotech and an emphasis on networking, this conference in Luxor is relevant for all in the field of nano: from ethicists and investors to biologists, chemists, and those in technology transfer. The meeting's program is wide-ranging, with sessions on topics such as environmental risks/benefits, fabrication, medical applications, and renewable energy. However, the underlying focus is on international involvement and dialogue in order to develop nanotech in a sustainable way—bridging the gap between the industrial and developing worlds.

3rd International Conference on Communication and Cooperation

April 16-19, 2007; Brussels, Belgium

<http://www.imec.be/inc3/Welcome.html>

This is another conference aimed at international collaboration and cooperation in nanotech. Industry leaders, policy-makers, and senior researchers are invited to participate in the meeting, which will have some emphasis on nanoelectronics in the technical sessions. There will also be sessions on the societal and economic implications of nanotech, and on intellectual property and problems associated with patenting nanotechnologies.

Hot-off-the-Presses Peer-Reviewed Research Articles of Note

Hyung, H., *et al.* 2006. "Natural organic matter stabilizes carbon nanotubes in the aqueous phase." *Environ. Sci. & Technol.* **ASAP Article.**

Abstract: http://pubs3.acs.org/acs/journals/doi/lookup?in_doi=10.1021/es061817g

Synopsis:

- This study investigated the aqueous stability of multi-walled carbon nanotubes (MWNTs) in the presence of both synthetic solutions containing model natural organic matter (NOM) and natural surface water with a high NOM background (Georgia's Suwannee River). This study was motivated by prior studies reporting stabilization of carbon nanotubes (CNTs) in the aqueous phase by well-characterized surfactants and polymers that raised questions regarding whether similar phenomena can occur between CNTs and organic molecules present in natural systems.
- MWNT suspensions were prepared by adding varying amounts of MWNT (5 to 50 g) to 100 mL of either Milli-Q water, a 1% sodium dodecyl sulfate (SDS) solution (*i.e.*, a surfactant used as a positive control due to its known CNT-stabilizing properties), or solutions containing varying amounts of either model NOM or Suwannee River water.

Following vigorous agitation for one hour, quiescent setting for four days, and removal of the unsettled supernatant, concentrations of suspended MWNTs were determined by a novel Thermal Optical Transmittance (TOT) method as well as by UV-vis absorbance and turbidity measurements.

- The study investigators found that the stability of MWNTs in the aqueous phase was largely determined by the presence of SDS or NOM. Although MWNTs added to 100 mL of Milli-Q water quickly settled, leaving behind completely transparent solutions, additions of equivalent amounts of MWNTs to either 1% SDS solutions or NOM solutions resulted in the formation of aqueous suspensions that remained stable for over 1 month.
- While Suwannee River water showed a similar MWNT stabilizing capacity as compared to the model NOM solutions, the same initial MWNT concentrations in both the Suwannee River water and NOM solutions yielded considerably higher concentrations of suspended MWNT than for the SDS surfactant solution used as a positive control.
- Microscopic analyses suggested that aqueous suspensions were dominated by individually dispersed MWNTs.

Implications:

- Although understanding the fate of nanoparticles such as CNTs is vital to assessing potential exposure routes for both humans and ecosystems, few studies have investigated the fate and transport of CNTs in natural and engineering environments. This study represents one of few published environmental fate and transport studies for CNTs.
- Due to observations that they are extremely hydrophobic and prone to aggregation, CNTs have not been widely considered to be potential contaminants in the aqueous phase. However, as discussed by the authors, these study findings suggest that "dispersal of carbon-based nanomaterials in the natural, aqueous environment might occur to an unexpected extent following a mechanism that has not been previously considered in environmental fate and transport studies.
- These findings indicate that due to stabilization by NOM in natural waters, there is the potential for exposure to individual, unaggregated CNTs following an environmental release. Given the largely undefined nature and variability in NOM depending on its source, additional studies are warranted to better characterize CNT interactions and long-term stabilization.
- In light of these findings, consideration should be given in environmental fate and transport analyses to the potential concentrations of CNTs that might be found in surface waters following inadvertent release.

Cherukuri, P. et al. 2006. "Mammalian pharmacokinetics of carbon nanotubes using intrinsic near-infrared fluorescence." *Proceedings of the National Academy of Sciences*. 103(50): 18882-18886.

Abstract: <http://www.pnas.org/cgi/content/full/103/50/18882>

Synopsis:

- Single-walled carbon nanotubes (SWNTs) have a variety of remarkable mechanical, thermal, electronic, and optical properties that suggest potential future biomedical uses including targeted chemotherapeutics, *in vitro* cell markers, and diagnostic imaging contrast agents. Before these medical applications can be developed, however, there must be a better understanding of the behavior and fate of SWNTs in mammals.
- Little is currently known about SWNT behavior and fate in mammals due in part to the difficulty in detecting and tracking these nanoparticles in complex biological environments. This study exploited the intrinsic near IR-fluorescence of individualized SWNTs to measure their blood elimination kinetics in rabbits as well as to identify the organs in which SWNTs accumulate.
- Four New Zealand rabbits were injected with a 7.5 mL bolus of a suspension of individualized (*i.e.*, disaggregated) SWNTs through jugular vein catheters. The dose of SWNTs was 75 µg, or about 20 µg/kg of body mass. At 0.5 and 24 hours after injection, 1 mL blood samples were collected. Rabbits were sacrificed 24 hours after injection, and organs and tissues were harvested for histopathology and near-IR fluorescence imaging.
- Analysis of the kidneys, lungs, spleen, heart, brain, spinal cord, bone, muscle, pancreas, intestine, skin, and liver revealed that the only significant SWNT concentrations 24 hours after injection was in the liver.
- Neither behavioral nor pathological exams revealed evidence of behavioral changes, gross organ abnormalities, or tissue pathologies, leading the authors to conclude that there was no acute toxicity for a SWNT dose of 20 µg/kg.

Implications:

- The authors concluded that their findings are suggestive of the low toxicity of low-level nanotube exposures.
- Based on their findings, the authors concluded that individualized SWNTs act as high-contrast near-infrared fluorophores, allowing for their sensitive and selective tracking in mammalian tissues via optical methods. The study authors highlight the sensitivity of near-fluorescence techniques to detect even a single intracellular nanotube.
- The authors quantified the kinetics of SWNT elimination from blood circulation, finding rapid displacement of nanotube coatings by blood proteins and a first-order (exponential) decay with a half-life of approximately one hour. Based on these findings, the authors concluded that the lack of biexponential or multiexponential kinetic components indicate the lack of reversible reservoirs or temporary accumulations in body tissues.

- The authors concluded that a reasonably long blood circulation time, an absence of acute toxicity, and the sensitivity of SWNTs to fluorescence tissue tracking support the high potential of SWNTs in future biomedical applications.

Anouncement

The *Journal of Industrial Ecology* is currently accepting article submissions for their upcoming issue on industrial ecology and nanotechnology. The deadline for submission is March 1, 2007; further detail can be found at <http://www.yale.edu/jie/cfnano.htm>.

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