Safety in the Laboratory

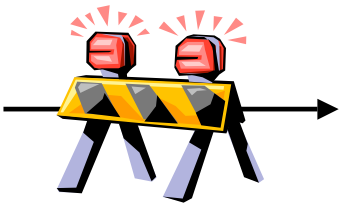
NSF-NSE Grantees Workshop

Ensuring Nanotechnology is Safe

Center Goals

Nanoparticles that detect and cure disease

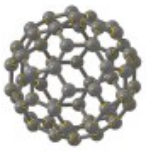
Effective water treatment systems using nanoparticles



2011 Outcomes

2 nanoparticle-based medical devices in human trials

A water treatment system using nanoparticles applied on a large scale



Nanotechnology Researchers Receive the Highest Exposures

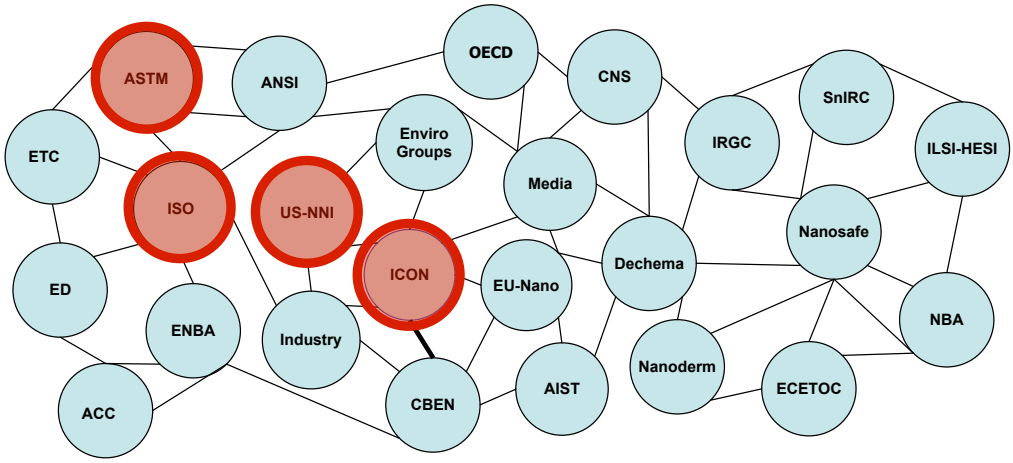
Safety Information: Huge Chasm

RESEARCH
Creation of new information

COLLECT	FILTER	SYNTHESIZE
VALIDATE	ORGANIZE	DEBATE
PRESENT	EXPLAIN	COMPARE
CRITIQUE	SUMMARIZE	
INFORM	**EDUCATE**	**FRAME**

DECIDE
Recommend Actions

Safety Information: The EH&S Network



Organizations with information, in some cases recommendations for occupational exposures

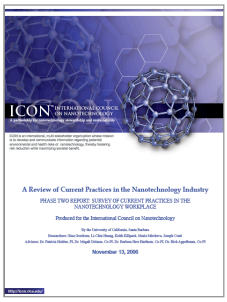
Common Themes and Principles

ASTM INTERNATIONAL

ISO International Organization for Standardization

NIOSH National Institute for Occupational Safety and Health

Approaches to Safe Nanotechnology – Handbook available online (updated in 2006, open for comment)



UCSB Survey on Current Practices funded by ICON

What follows is my summary of these great documents

Warning: I am not an occupational health scientist

New partnership models

ICON™ INTERNATIONAL COUNCIL ON NANOTECHNOLOGY

Your source for information about nanotechnology environmental health & safety

RICE UNIVERSITY

CBEN

SEARCH

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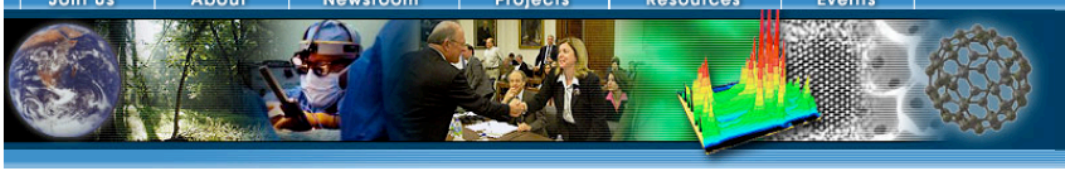


Media Monitor | New from the Council | Items of Interest

- International partnership which includes many stakeholders
- Pooled resources for risk management of nanotechnology
- Shared risk communication strategies
- *Major effort in database and knowledge base for NanoEHS*

www.rice.edu/icon

UCSB Current Practices Survey

UCSB Team: Dr. Patricia Holden, PI, Dr. Magali Delmas, Co-PI, Dr. Barbara Herr Harthorn, Co-PI, Dr. Rich Appelbaum, Co-PI

- Survey completed with ~70 organizations; questions on current practices for EH&S
- EHS practices reported are conventional safety practices for handling chemicals.
- Lack of information cited as an impediment for implementing nano-specific EHS.
- For organizations with nano-specific EHS the methods are a precaution against unknown hazard
- Dust masks widely reported when handling nanopowders
- Academia less likely to use containment/isolation as a control mechanism

International Standards

WK 8985 STANDARD GUIDE FOR HANDLING UNBOUND ENGINEERED NANOPARTICLES IN OCCUPATIONAL SETTINGS

Lead: Dr. Steve Brown, Intel
Anticipated release ~ May 2007
Volunteers are welcome!!

TC 229 Work Item on Monitoring Nanoparticle Exposures in Workplace Atmospheres

NIOSH – U.S. Government

NIOSH National Institute for Occupational Safety and Health

Approaches to Safe Nanotechnology – Handbook available online (updated in 2006)

"Until the results from research studies can fully elucidate the characteristics of nanoparticles that may potentially pose a health risk, precautionary measures are warranted."

Step 1: KNOW your material

Step 2: FOLLOW good work practices

Step 3: ACTIVELY PROTECT workers

Step 4: MONITOR workers and exposures

http://www.cdc.gov/niosh/topics/nanotech/safenano/

Step 1: "KNOW" – MSDS is not useful

"Nano" materials = Bulk material for EHS properties

Material Safety Data Sheet
acc. to OSHA and ANSI ….

8. Physical and chemical properties:

- **Solubility in / Miscibility with Water:** Insoluble

11 Toxicological information

- **Acute toxicity:**
- **Primary irritant effect:**
- **on the skin:** Irritant to skin and mucous membranes.
- **on the eye:** Irritating effect.
- **Sensitization:** No sensitizing effects known.
- **Subacute to chronic toxicity:**

Elemental carbon/carbon black is mainly a nuisance dust. It is irritating to the eyes and may cause conjunctivitis, cornea damage, and inflammation of the eyelids.

Additional toxicological information:

To the best of our knowledge the acute and chronic toxicity of this substance is not fully known.

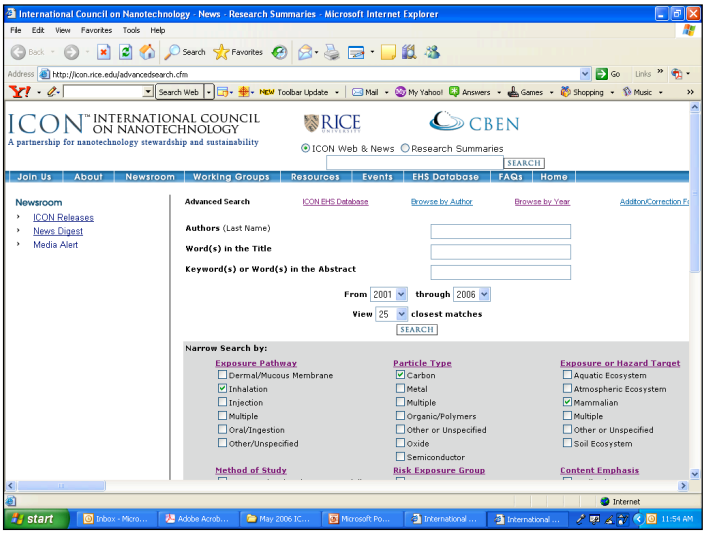
14. Ecological hazards

…**National regulations**

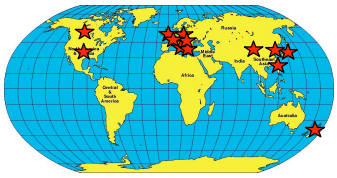
This product is not listed in the U.S. Environmental Protection Agency Toxic Substances Control Act Chemical Substance Inventory. Use of this product is restricted to research and development only.

ASTM document calls for this to be required for nanomanufacturers

Step 1: ICON EHS Technical Literature



An informed decision about how to ensure the safety of nanomaterials requires a comprehensive review of where we are and where we've been with prior research. By gathering findings that are scattered throughout the literatures of biomedical application developers, toxicologists, environmental engineers and nanomaterials scientists, we are helping researchers and government funding agencies to see the big picture.



- Over 1500 records
- 50% of hits are from outside the US

http://icon.rice.edu/research.cfm

Step 1: NIOSH Nanoparticle Library

- Voluntary reporting of nanoparticles
- Diverse set of materials
- TEM and other properties available
- Health and Safety data if known

http://www2a.cdc.gov/niosh-nil/index.asp

Step 2: Follow Good Work Practices

- No eating or drinking in the laboratory
- No blowing, dry wiping, use of normal vacuums
- Wear safety glasses at all times
- Use some kind of glove and labcoat routinely
- Isolate any nanoparticle sources where feasible
- Wet wipe counters routinely
- Provide hand-washing and showers
- Vacuuming exposed areas with HEPA filter units

Most chemists are well trained in these practices; however, this training is not consistent across disciplines

Step 3: Actively Protect Workers

- Explosion: This could be a real issue for nanoparticles, especially metal powders
- Fire: High surface area materials can ignite at lower temperatures
- Catalytic behavior may exacerbate the above

Significant Explosion Issue (e.g. Bhopal) unlikely in laboratory

Step 3: Hoods and Glove Bags

www.labds.com

www.haverford.edu

- Chemical hoods are appropriate protection (HEPA filter)
- Glove bags a good choice for powders that get disturbed

Step 3: Respirators

www.equipdirect.com

www.gossersales.com

- Full respirator 5X more effective than disposable face mask
- Proper fitting for respirators is essential
- NIOSH suggests ‘professional judgment’ for when to use

NIOSH and ASTM documents have tables on respirators

Protective Clothing (especially gloves)

"Currently, no guidelines are available on the selection of clothing or other apparel for the prevention of dermal exposure to nanoparticles. *" - NIOSH 2006*

- Against 477 nm particles barrier effectiveness ~ 12%
- Some gloves (biohazard) rated against viruses ~25 nm
- Gloves essential for barriers to volatile organics
- ASTM Standard F1461 – Discusses gloves and their limits

Choose gloves based on resistance

Latex

Nitrile

$10/100

	Latex	Nitrile
Hydochloric acid (30%)		
Isopropyl Alcohol		
Acetone		
Toluene		
Chloroform		
Dimethyl Sulfoxide		

Other gloves include butyl rubber and viton materials

http://www.deltagloves.com/chemchart.htm

Step 4: Monitoring and Surveillance

- Exposure monitoring – no good solution right now
- Must examine several scenarios for tracking workers

A cancer cluster from nanomaterial waste?

Allergic reactions to nanomaterials?

Essential: Set priorities for research, monitoring and policy

The Ideal Nanolaboratory Worker

A HEPA filter chemical hood

Full face shield + safety glasses

Chemical gloves

Lab coat

learn.caim.yale.edu/.../hood_chemicals.gif

Contacts and sites for follow-ups

http://icon.rice.edu/research.cfm - Survey of current practices in industry and academia

http://www2a.cdc.gov/niosh-nil/index.asp - Links to NIOSH handbook and nanoparticle information library

http://www.astm.org – Voluntary standards development, you can join and write/vote/learn

Explore these yourselves and encourage your group as well