

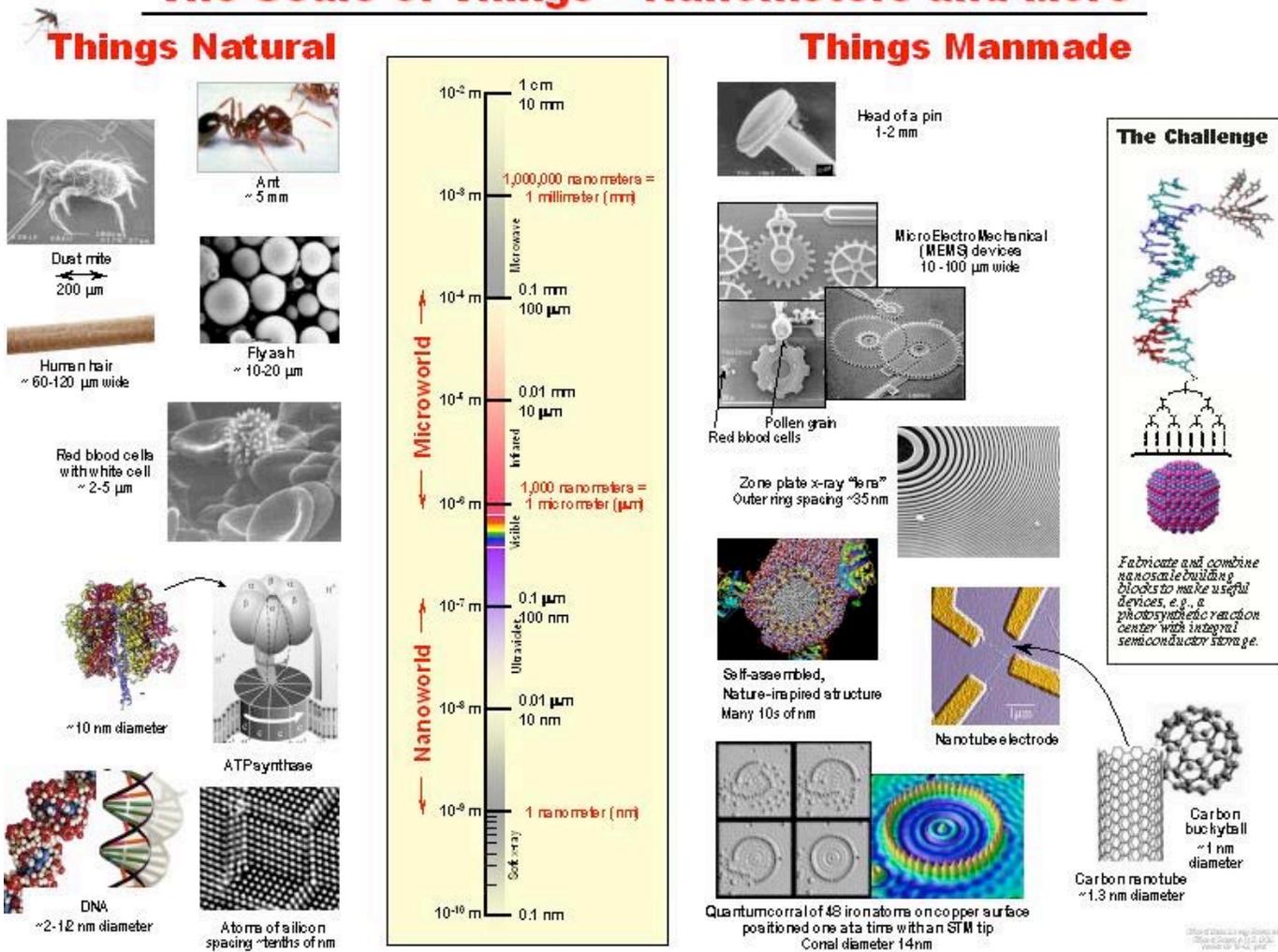
What is Nanotechnology?

Nanotechnology is the understanding and **control** of matter at dimensions of roughly 1 to 100 nanometers, where **unique phenomena** enable **novel applications**.

Encompassing nanoscale science, engineering and technology, nanotechnology involves imaging, measuring, modeling, and manipulating matter at this length scale.

The Nanoscale

The Scale of Things – Nanometers and More



What /s Nanotechnology?

Common Public Perception

1st Major New Class of Materials Since Polymers

Common Sci/Eng Perception

Photo by Felice Frankel

Size Matters

(Accidental)
Nanotechnology



Rose Window of
Notre Dame in Paris



Bulk Gold = Yellow



Nanogold = Red



Properties that can change at/along the nano-scale include:
Color, reactivity, magnetism, friction, electrical conductivity...

Future Nano

Battlesuit that monitors health, eases injury, communicates & enhances performance



Able to leap tall buildings in a single bound?

Cancer detection and treatment in a single office visit



Hypospray: Nano Inside?

Elevator that ferries satellites, spaceships, and pieces of space stations into space



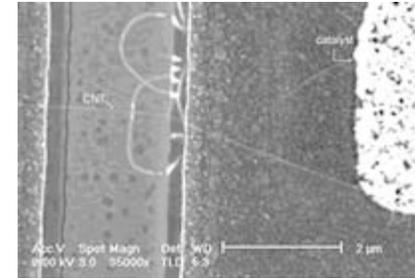
Potential Benefits are Numerous

Energy



DOE

Electronics



Stanford University

Medicine



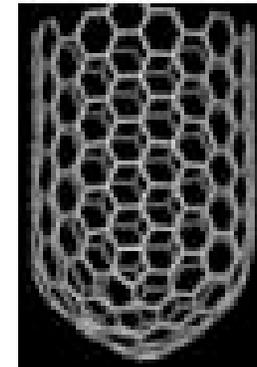
CBEN Rice University

Defense



MIT Institute for Soldier Nanotechnologies

Materials



DOE

Different Types of Nanomaterials

Engineered nanomaterials are very diverse with near limitless tunability

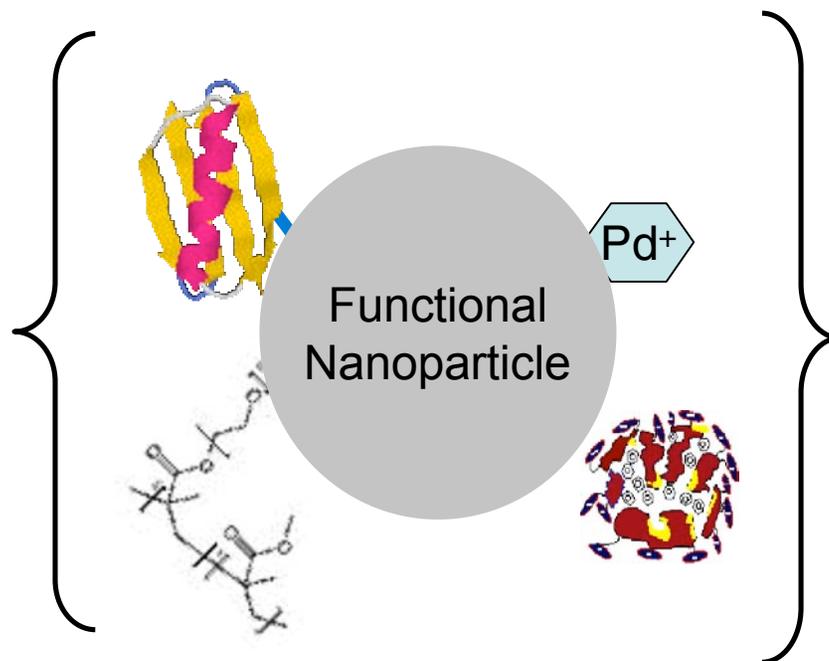
Naturally Occurring	Human Origin (incidental)	Human Origin (engineered)
Forest fires	Cooking smoke	Buckyballs
Sea spray	Diesel exhaust	Quantum dots
Mineral composites	Welding fumes	Nanotubes
Volcanic ash	Industrial effluents	Nanocapsules
Viruses	Sandblasting	Sunscreen pigments

Nanotechnology





Theme 2: Nanoparticles for Medicine (West)



Theme 1: Nanoscience at the Wet/Dry Interface (Colvin)



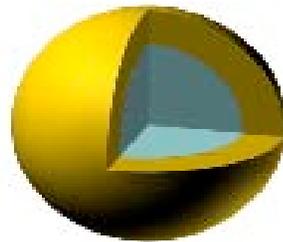
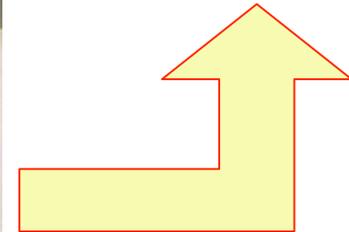
Theme 3: Nanoparticles for the Environment (Alvarez/Hughes)

Applications: Nanoshell "Tunability"

Changing the size of the nanoshell affects where it absorbs light

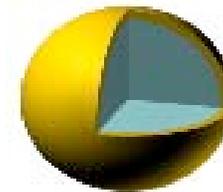


Near-infrared



60 nm Core Radius
20 nm Shell

→
Increasing
Core : Shell Ratio

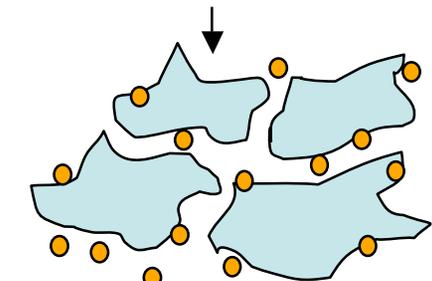


60 nm Core Radius
5 nm Shell

Drezek, West et al., Ann. Biomed. Eng., 2006; West, Drezek, et al., J. Biomed. Opt, 2005

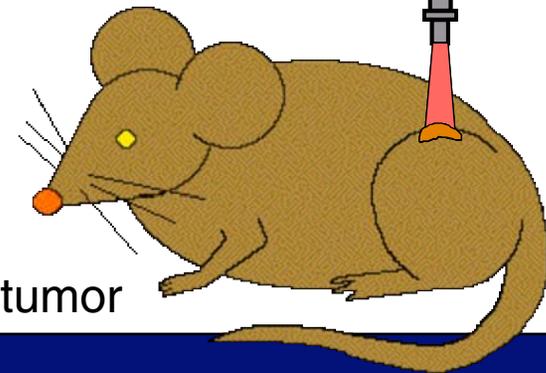
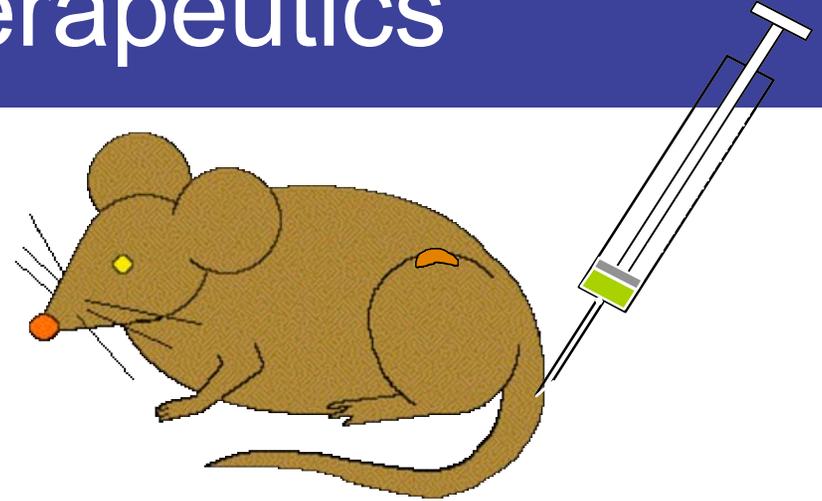
Nanoshell-based Therapeutics

Cancerous cells



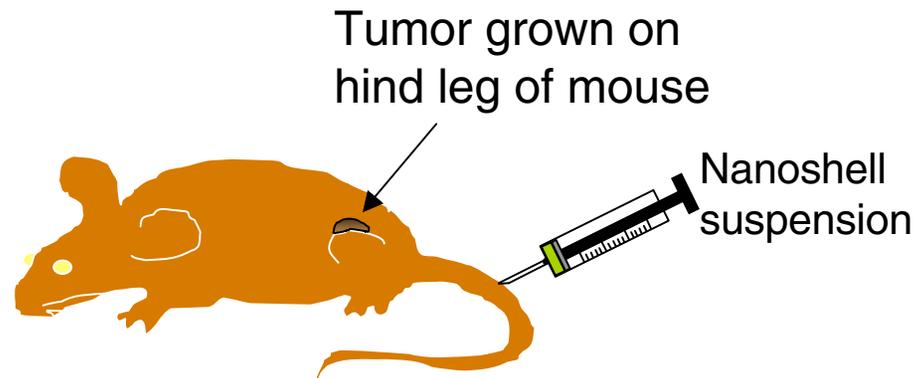
Tumor capillary

"Leaky" endothelium



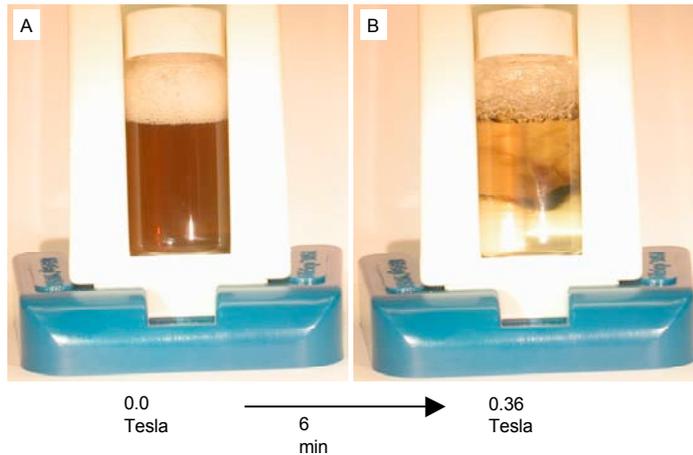
NIR light induces heating of nanoshells, destroying tumor

Integrated Imaging and Therapy

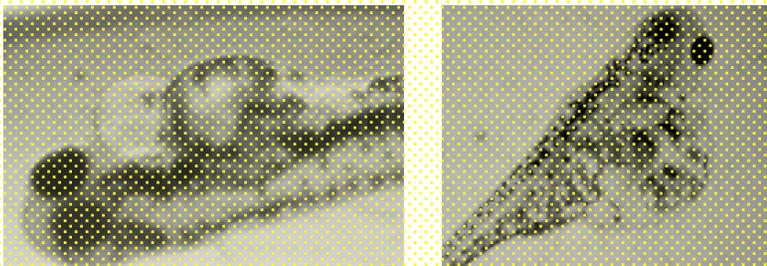


Drezek, West, et al., submitted to Nat. Biotech.; Drezek, West, et al., NanoLetters, 2005

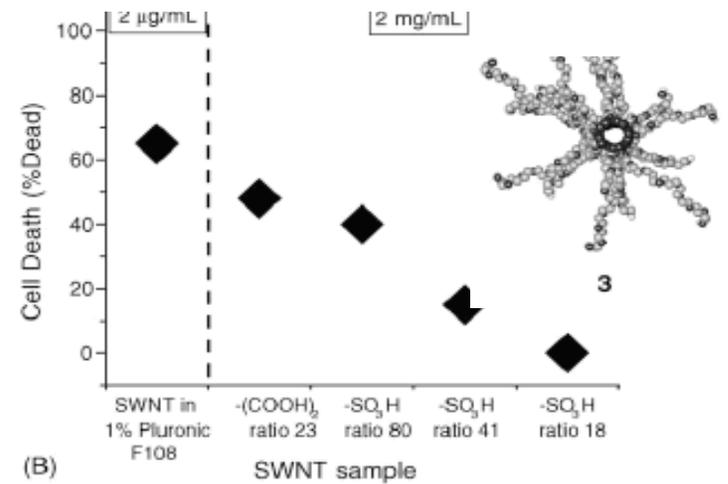
CBEN Research Highlights



Nano magnets soak up poisonous arsenic (Tomson, Colvin)



Buckyball aggregates cause pericardial edema in zebrafish (Alvarez, Tomson, Colvin)



Surface modifications reduce nanotube toxicity (Colvin, West)

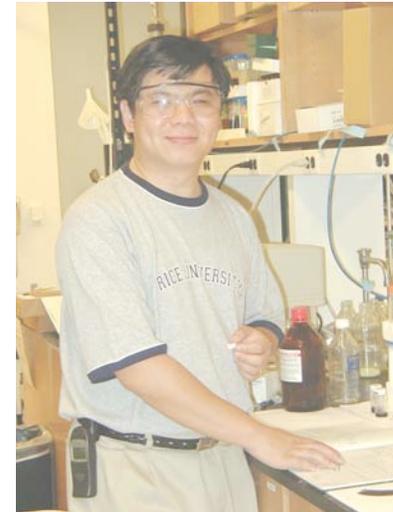
Risk: Three Areas of Concern



End-of-use issues:
Ecological impacts



Direct consumer
contact



Worker and
laboratory safety

What do we know about the “implications” of nanomaterials?

Nano Scare Story?



Magic Nano bath sealant

- Bathroom sealant allegedly created a nanoscopic film on tiles, purported to contain nanoparticles
- Caused over 100 cases of "intoxication"
- Multinational product recall within days of product release
- ... this event as a nano

NOT Nano

Technology
AN MIT ENTERPRISE
Review

Monday, April 10, 2006

"Nano" Safety Recall

[washingtonpost.com](http://www.washingtonpost.com)

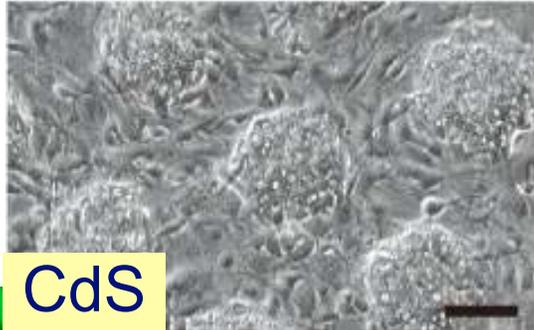
**Nanotech Product Recall Underscores Need
for Nanotech Moratorium:
*Is the Magic Gone?***

Nanotech Product Recalled in Germany

News Release
ETC Group
April 7, 2006
www.etcgroup.org

Prelim Hazard Data Causes Concern

Derfus et al (2004). Nanoletters



CdS

Photo: Massimo Lorenzoni

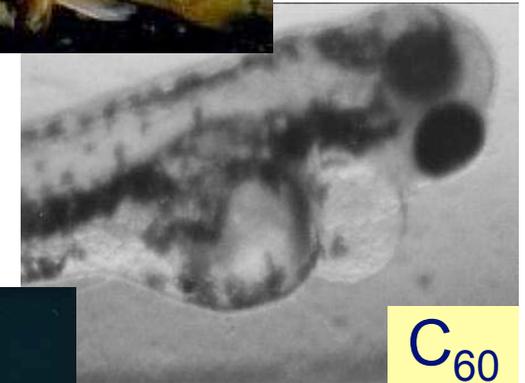


C₆₀

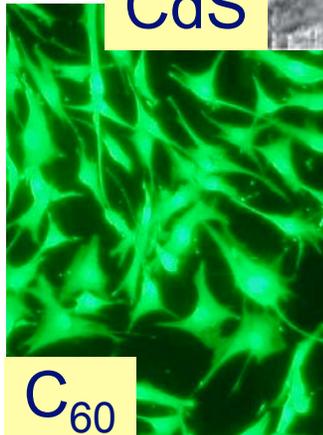
Picture: SIMON O'DWYER



Nanotubes

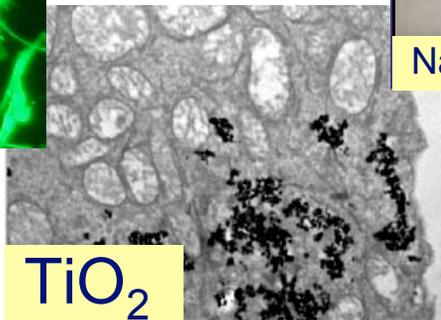


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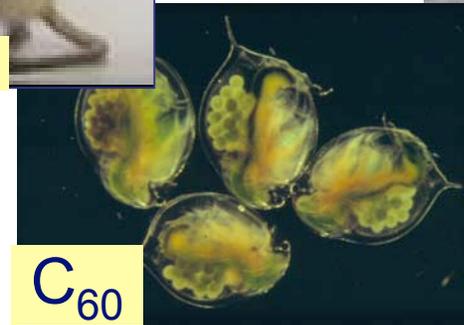
C₆₀

Sayes et al (2005)
NanoLetters



TiO₂

Long et al (2006). ES&T

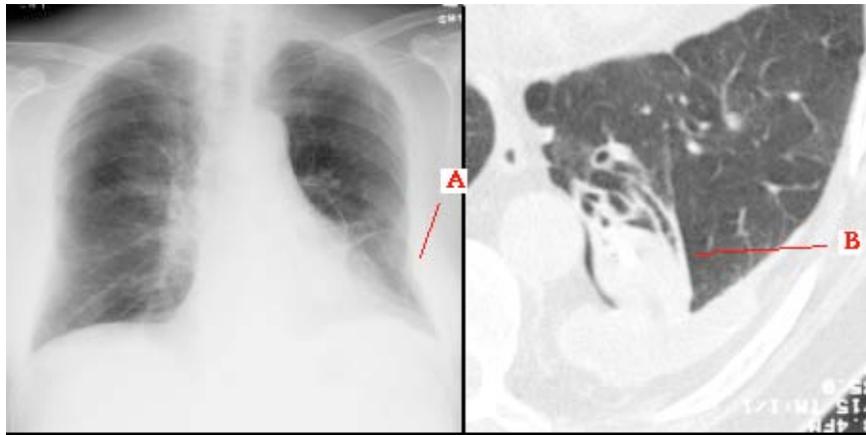


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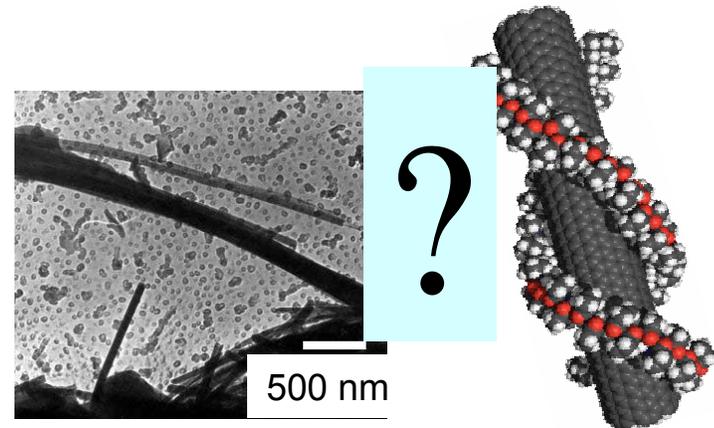
www.brixham-lab.com

CBEN Rice University

Nanotechnology and Risk: Technical Data



Human lung and asbestosis



Asbestos

SWNT

The technical data in this field is highly complex and may remain controversial for some time

- Overgeneralizing nanomaterial behavior (good or bad)
- Poor analogies between ultra-fine and engineered nanoparticles
- Many exposure settings (workplace, consumer ...) and material types
- Poorly developed analytical tools and methods for risk assessment

How Risk Research Stacks Up

US Fed Funding

Source: PEN, Wilson Center

$$\frac{\text{NT EHS}}{\text{NT}} \cong 1\%$$

Publications

Source: Lux Research, ICON

$$\frac{\text{NT EHS}}{\text{NT}} \cong 1\%$$

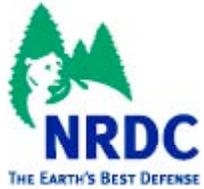
All numbers for 2005

Calls for More Risk Research

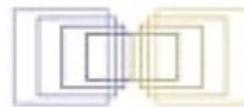
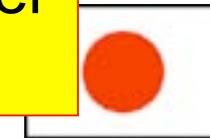
NGO's

Industry

Governments



How can we bring these groups together to achieve a common goal?



The International Council on Nanotechnology

All stakeholders communicate and cooperate in nanotechnology EHS

- Experts from academia, industry, government and non-profit organizations
- Transparent and shared governance

A global perspective on the potential risks of nanotechnology

- Members from N. America, Europe & Asia
- International stakeholder meetings held around the world

Developing and communicating information regarding potential environmental and health risks of nanotechnology thereby fostering risk reduction while maximizing societal benefit.

High quality technical information and knowledge capsules for all levels

- ★ World's first publicly accessible database of nano-EHS citations
- White papers summarizing current knowledge on specific aspects of nano EHS

Stewardship for sustainable nanotechnology

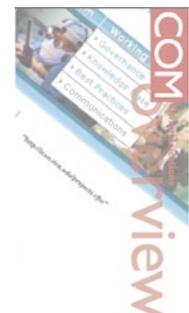
- ★ Survey of current practices for nanomaterial handling in the workplace
- Best practices for nanomaterials throughout product lifecycle

ICON's Mission

To develop and communicate information regarding potential environmental and health risks of nanotechnology thereby fostering risk reduction while maximizing societal benefit.

We do this by supporting activities and policies that are:

- ✓ Multi-stakeholder
- ✓ International
- ✓ Unbiased
- ✓ Technically based



ICON Meets Needs for Information

High-quality information about nanotechnology's risks and benefits

ICON™ INTERNATIONAL COUNCIL ON NANOTECHNOLOGY
A partnership for nanotechnology stewardship and sustainability

Join Us | About | Newsroom | Working Groups | Resources | Events | EHS Database | FAQs

Media Monitor

Regulating nanotech debated: Ensuring safety without stifling key innovations
SFGate.com
12 June 2006

Nanotechnology Risks - The Real Issues
nanoRISK Newsletter
12 June 2006

Beware the new nano sunscreens
Northern Express
12 June 2006

Building Nanoliteracy in the University and Beyond
Nature Biotechnology Article
09 June 2006

Nanotechnology Information Provider Publishes Premiere Edition of 'nanoRISK'; Newsletter will make 'Constructive Contribution'
PR Newswire

New from the Council

ICON and UCSB Invite Participation in Documenting Current Practices for Nanomaterial Handling
News Release
More Information
08 June 2006

ICON Holds Stakeholder Workshop - May 9/10, 2006
Press Release (pdf)
Meeting Notes/Presentations
11 May 2006

Items of Interest

Environmental Defense Position on TSCA's PMN Provisions for Engineered Nanomaterials
Environmental Defense Letter
05 June 2006

23 June 2006: Empa Nano-Convention '06, Kursaal Bern, Switzerland
Program Registration
01 June 2006

Groups Petition FDA to Amend Regulations on Products Containing Nanoparticles
CTA Press Release
More Information
17 May 2006

Public Information Portal

Over 1500 online records from MEDLINE, TOXNET, NTIS, and Web of Science

Search the EHS Database By:

- Author
- Year (1962-Present)
- Advanced Search
 - Exposure Pathways
 - Method of Study
 - Material Production
 - Particle Type
 - Risk Exposure Group
 - Target Audience
 - Exposure or Hazard Target
 - Content Emphasis
 - Publication Type

• Abstracts

• Summaries

• Citations and Links

to Full Research Papers

EHS Literature Database

Current Practices Overview

Nanomaterial Handling Survey

More information

For more information see our websites:

<http://cben.rice.edu>

<http://icon.rice.edu>

Or contact me at:

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