

# **EPA & Nanotechnology: Research Activities to Meet Policy and Regulatory Needs**

## **5<sup>th</sup> U.S.-Korea Forum on Nanotechnology**

*Nora Savage, PhD*

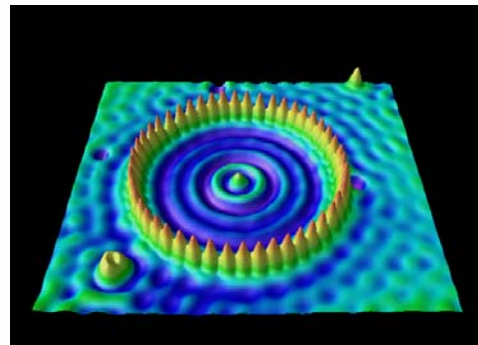
*US EPA,  
Office of Research & Development  
National Center for Environmental Research  
Environmental Engineering Research Division*

# OUTLINE

- Nano – What is it to EPA?
- EPA Interests
- EPA Research Needs
- EPA Research Activities
  - Internal
  - National
  - International
- Research Results – Dissemination & Use

# What Is Nanotechnology?

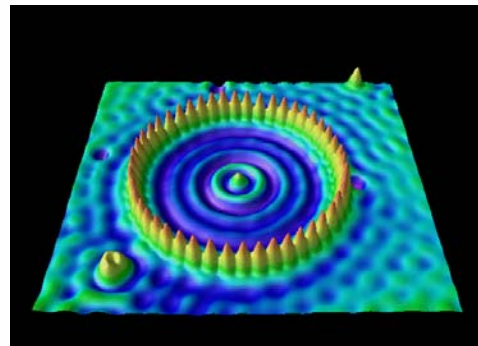
- ❖ Research and technology development with matter  $\sim$  1 - 100 nanometers
- ❖ Ability to understand, create, and use structures, devices and systems with fundamentally new properties and functions due to nanoscale structure
- ❖ Ability to control – to see, measure, and manipulate – matter at these dimensions to exploit those properties and functions
- ❖ Ability to integrate those properties and functions into systems from nano- to macroscopic scales



**Corral of Fe Atoms – D. Eigler**

# What Is Nanotechnology?

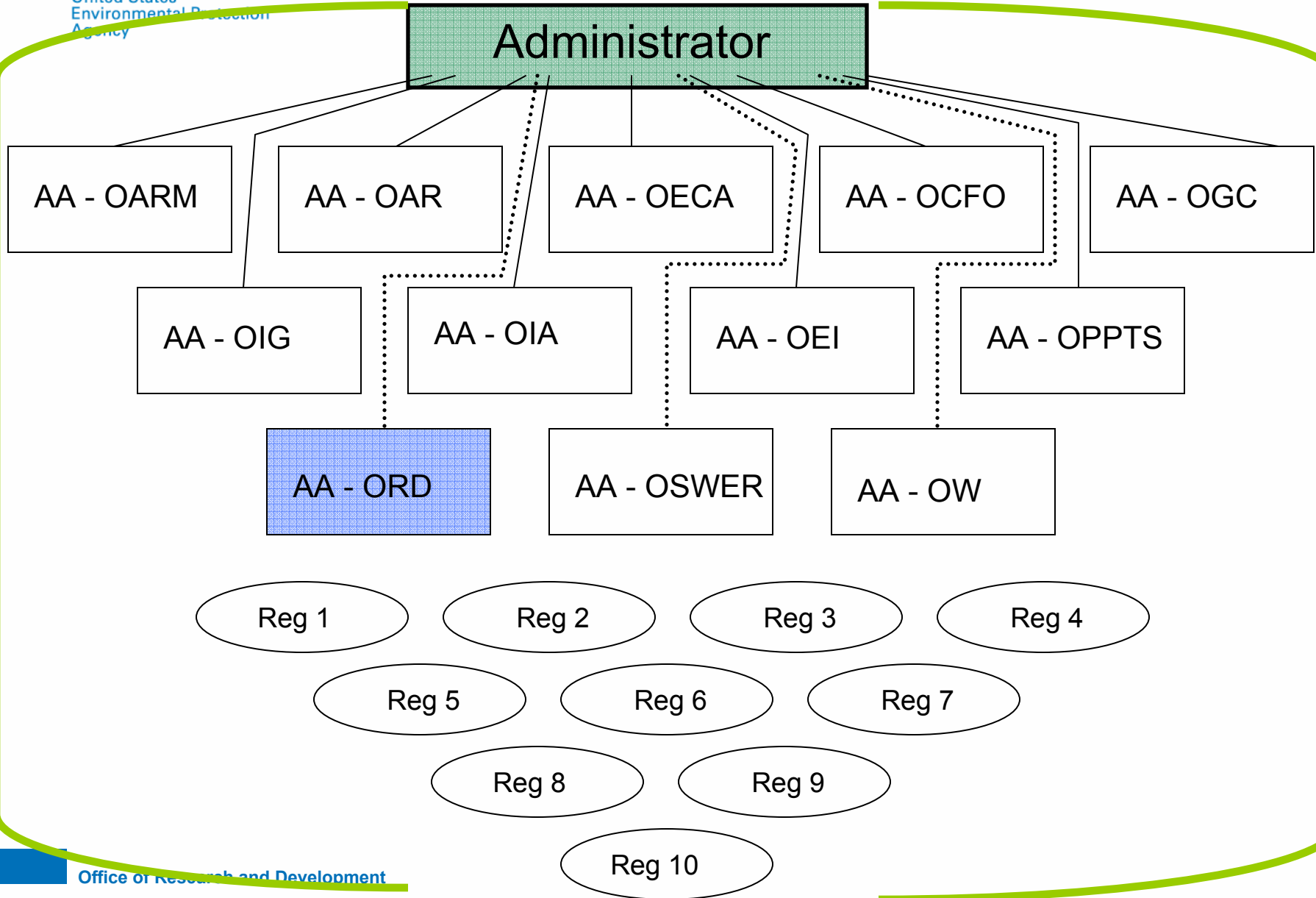
- ❖ How does “uniqueness translate to :
  - ❖ Different approaches to human and eco toxicity
  - ❖ Changes transport capabilities
  - ❖ Altered material upon exposure
  - ❖ Changes in ultimate fate
  - ❖ Determination of where in product life cycle exposure is likely to occur



**Corral of Fe Atoms – D. Eigler**

# EPA Organization

~18,000

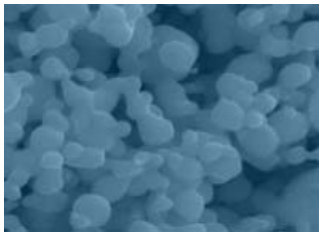


# EPA Interest Material Source

## Anthropogenic

### Engineered

- Carbon-based  
NTs, Fullerenes
- Metal Oxides
- Quantum Dots
- Nanotubes
- Nanowires
- Dendrimers



### Incidental

Particles from:

- Combustion
- Industrial  
Processes
- Vehicles
- Construction



## Natural

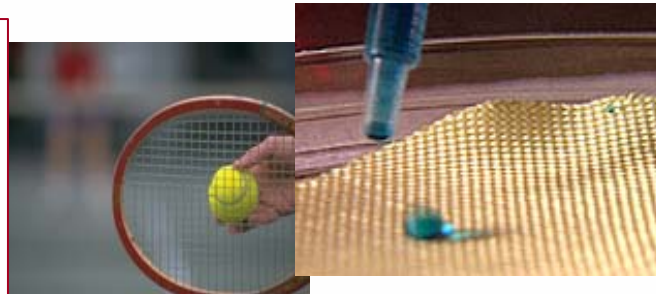
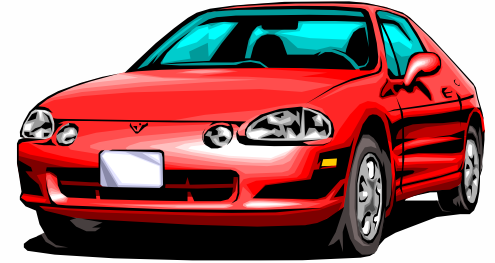
Particles from:

- Plants, Trees
- Oceans, other  
water bodies
- Erosion
- Dust



# EPA Interest Consumer Products

- Self-cleaning glass, ceramics, and metals
- Stain-free clothing and mattresses
- Lighter weight, stronger materials
  - Automobile bumpers, tennis racquets
- More efficient, cheaper catalytic converters on cars
- Longer lasting tires and tennis balls
- Improved dental-bonding/filling materials
- New types of burn and wound dressings
- Impermeable materials for food packaging



# EPA Interest

## Material Characterization

### Unique Properties of Nanoscale Materials

- Chemical reactivity of nanoscale materials greatly different from more macroscopic form, e.g., gold
- Vastly increased surface area per unit mass, e.g., upwards of 100 m<sup>2</sup> per gram
- Quantum effects resulting in unique mechanical, electronic, photonic, and magnetic properties
- New chemical forms of common chemical elements, e.g., fullerenes, nanotubes of carbon, titanium oxide, zinc oxide, other layered compounds



- **Fulfill mission**

- Develop appropriate risk assessment & risk management approaches

- **Provide leadership**

- U.S. and global communities - environmental apps and impls

- **Support research**

- Enhance collaborations, increase knowledge base

- **Address statutory requirements**

- CAA, CWA, FIFRA, RCRA, SDWA, TSCA, etc.

- **Encourage proactive approach**

- Predictive tools (SARs, comp tox), P2, SxD

## Nanomaterial Research Strategy (NRS)

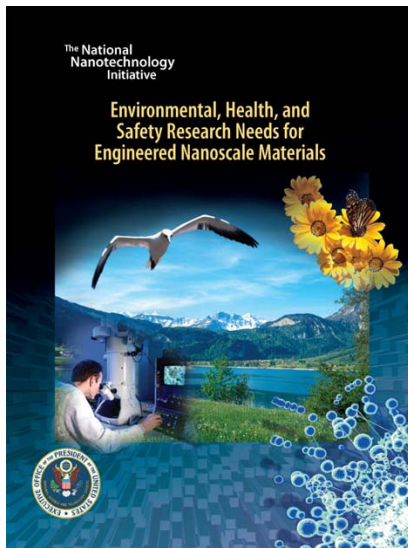
In fiscal years 2007 and 2008, EPA will focus on the following high priority areas.

Based on White Paper & NEHI documents

- Environmental fate, transport, transformation
- Exposure
- Monitoring and detection methods
- Effects assessment methods consistent with and derived via exposure information.

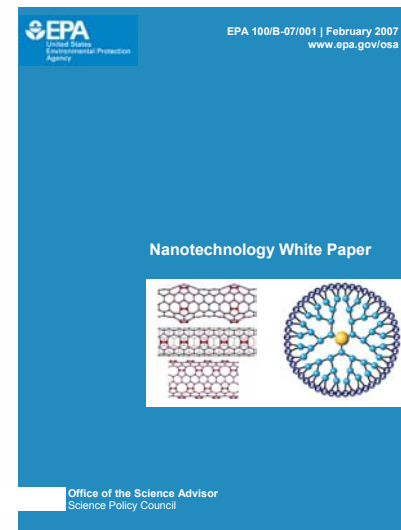
# EPA Nanomaterial Research Strategy – based on...

Nanotechnology Environmental  
and Health Implications (NEHI)  
Interagency Working Group of  
NSET, (NSTC, 2006)



[http://www.nano.gov/NNI\\_EHS\\_research\\_needs.pdf](http://www.nano.gov/NNI_EHS_research_needs.pdf)

EPA White Paper on  
Nanotechnology (EPA, 2007)



<http://www.epa.gov/OSA/pdfs/nanotech/epa-nanotechnology-whitepaper-0207.pdf>

# Research at EPA

**Applications** – use nano to improve monitoring/detection and remediation techniques, pollution prevention

(Approx. \$12.2 M to date)

**Implications** – assess the interactions of enms (human & env), exposure, and possible risks that may arise

(Approx. \$17.8 million to date, excluding ultrafine)



# Extramural (STAR) Research at EPA

- Initiated in 2002
- \$5.0 M/year
- STAR researchers positioned as leaders in nano EHS
- \$4 M FY 2008, for STAR research, \$1 M CEIN w/ NSF
- Opportunities to work with EPA nano rescuers

# In-House Research at EPA

- Initiated in 2007
- \$3.0 M
- Position EPA labs and staff
- \$5 M FY 2008, research initiated
- Opportunities to work with STAR and federal researchers

# 2007 Solicitation

## Environmental Effects of Nanomaterials

- Joint with Department of Energy (DOE) and National Science Foundation (NSF)
- Investigating Environmental Effects of Manufactured Nanomaterials – fate/transport & exposure
- \$6 million, \$400 K/yr, 3-yr awards
- Collaborative with EC researchers encouraged
- Opened May, closed August
- 120 Proposals received 34 passed peer review
- 16-18 new awards

# 2007 Solicitation with NSF

## Center for Environmental Implications of Nanotechnology

- National Science Foundation (NSF) lead
- Investigating Environmental Effects of Manufactured nanomaterial – fate/transport & exposure
- \$5 million per year, 5 years
- Opened September 12, 2007,
- Center award – fall 2008

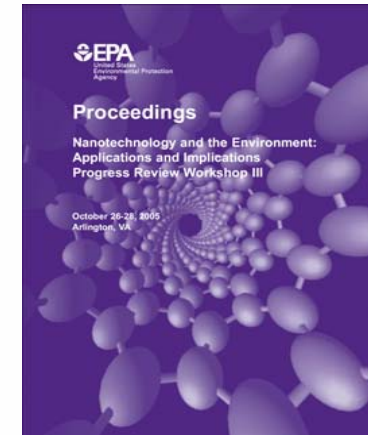
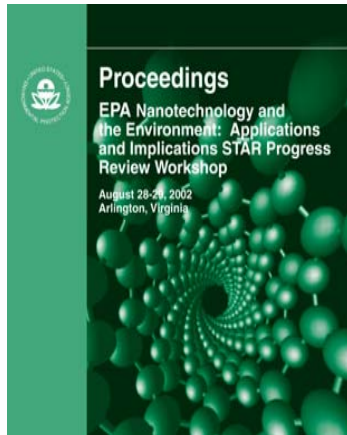


# 2008 STAR Solicitations

## Fate/Transport, Bioavailability, Toxicity

- Seeking collaboration with federal agencies
- Potential for sub-awards to Thailand researchers
- Seeking collaborative efforts with other countries
- Scheduled to open late summer early fall 2008

# STAR Grantees' Meetings – Proceedings



- 2007 Meeting Washington, DC September 5-7
- Research Abstracts, Annual Reports

<http://www.epa.gov/ncer/nano>

# *Nanomaterials – Applications & Implications*

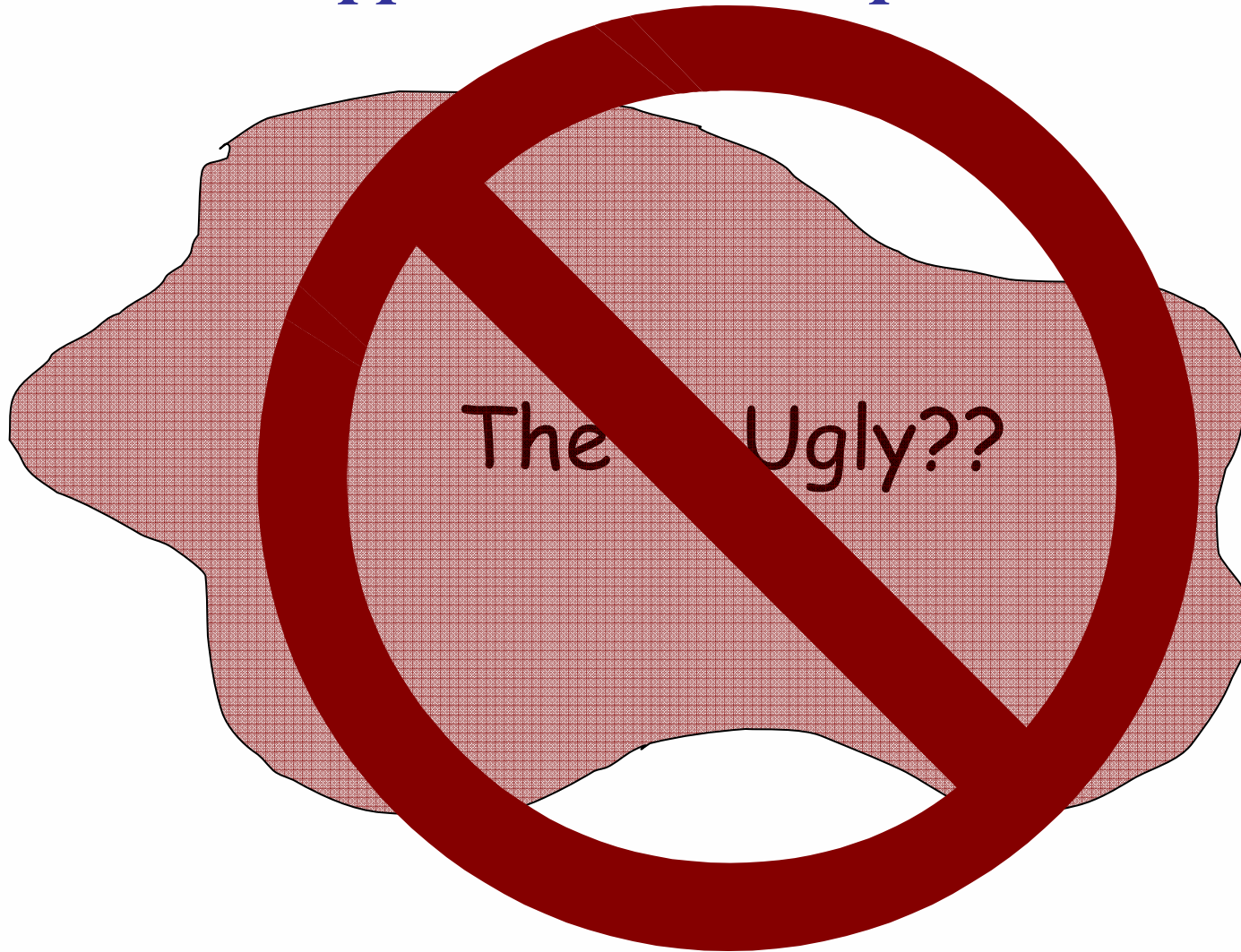
## The Good...

- Cross blood-brain barrier – drug delivery
- Placed in subsurface areas - remediation
- Small, real-time sensors – detection & protection
- Same compound, different properties – novel uses
- Different disciplines – increased collaboration

## The Bad...

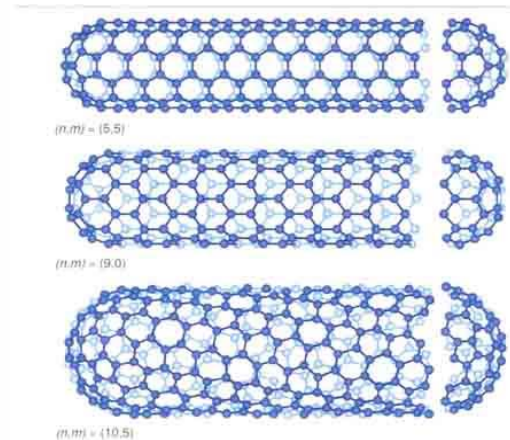
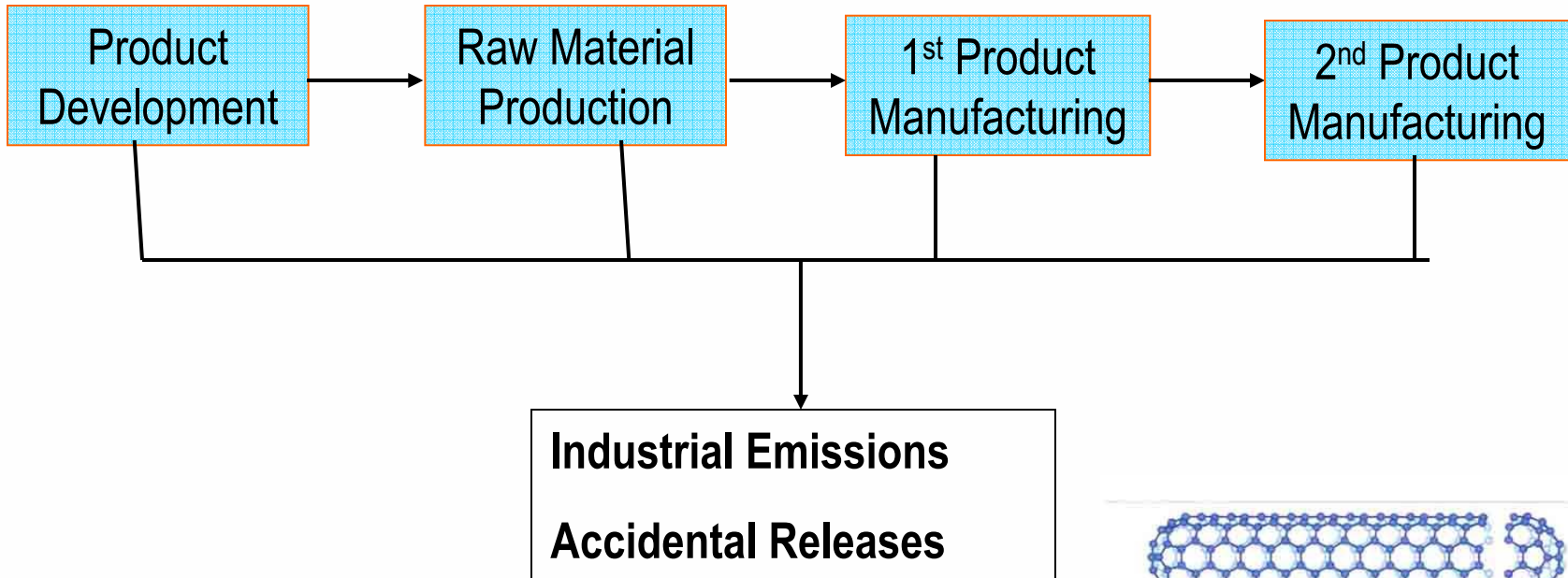
- Cross blood-brain barrier – impair health
- Placed in subsurface areas – impair ecosystem
- Small, real-time sensors – privacy concerns
- Same compound, different properties – reg. concerns
- Different disciplines – limited understanding

# *Nanomaterials – Applications & Implications*



# Risk Assessment – Life-Cycle Perspective

## Worker Exposure

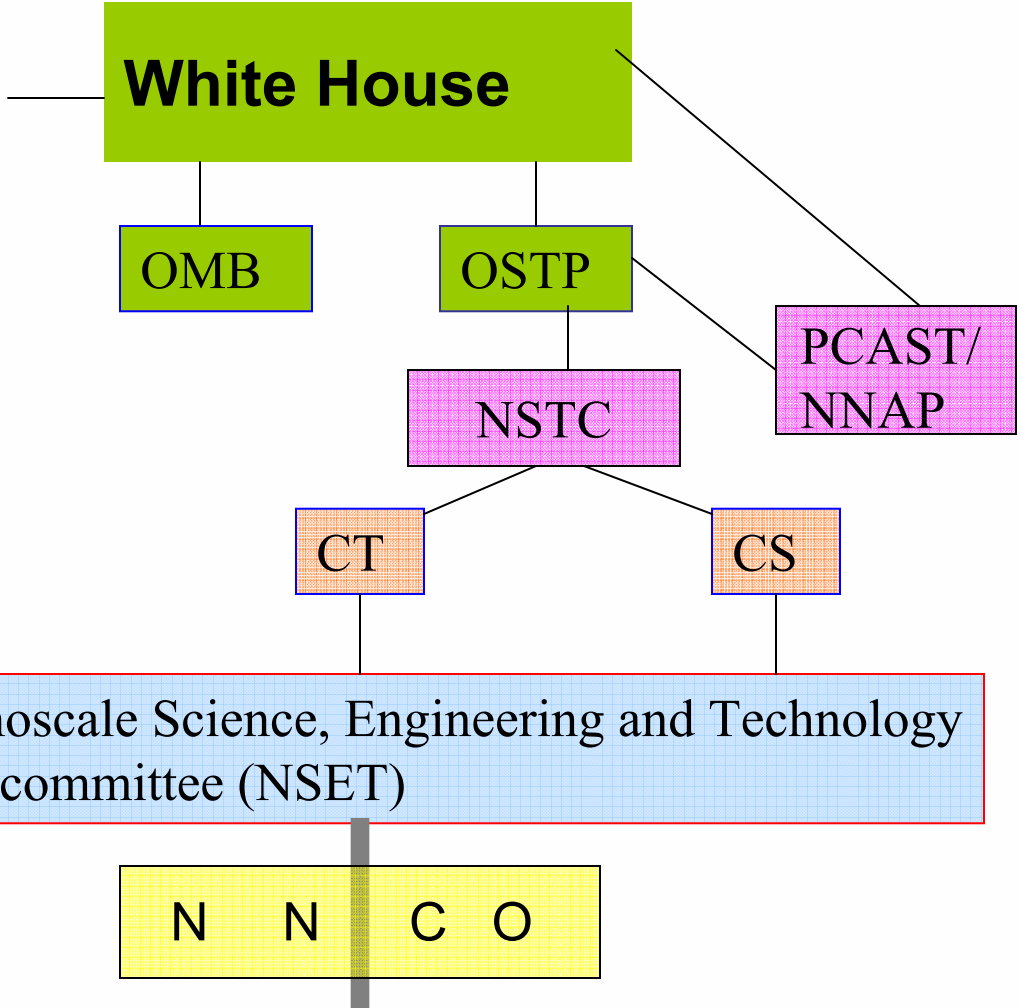


Nano Env. And Health Impl.  
(NEHI)

Nano Innovation Liaison  
with Industry (NILI)

Nano Public Engagement  
Group (NPEG)

Global Issues In  
Nano (GIN)



Nanoscale Science, Engineering and Technology  
Subcommittee (NSET)

N N C O

NSET Government Departments and Agencies (25):  
 CPSC, DHS, DOC, DOD, DOE, DOEd, DOJ, DOL, DOS, DOT,  
 DOTransp, **EPA**, FDA, IC, ITC, NASA, NIST, NIH, NIOSH,  
 NRC, NSF, OMB, OSHA, PTO, USDA



# International Research Activities

- Discussions underway w/ international research sponsors – collaborative RFAs
- Discussions with international partners on nanomaterial
- Collaboration with ILSI/HESI Nanomaterial EHS Project Committee
- Participation in ICON
- Pending collaboration with DEFRA UK

# International Meetings

## 2008 SETAC World Congress, Sydney. Australia

- Full-day symposium, 17-speakers
- Co-chairs from US, UK, & Australia

## International Environmental nanotechnology conference: Applications & Implications, Chicago, IL

- October 6-8, 2008
- Hyatt Regency Chicago
- Morning plenaries, 4-parallel afternoon sessions



NOW...

## Nanotechnology Home



**Nanotechnology**

**Factsheet**

**Solicitations**

**Newsroom**

**Research Projects**

**Publications &  
Proceedings**

Nanotechnology has both applications and implications for the environment. EPA is supporting research in this technology while evaluating its regulatory responsibility to protect the environment and human health. This site highlights EPA's research in nanotechnology and provides useful information on related research at EPA and in other organizations.

<http://www.epa.gov/ncer/nano>

# Ways to Collaborate

- Joint selection of enms for coordinated research
- Symposia, conferences, and workshops
- Sponsors Research Meetings
- Feedback on Agencies nano research initiatives

# SUMMARY

- Support research (internally, externally, nationally, internationally) to provide data needed to make policy and regulatory decision on emerging contaminants, proactive
- Lay foundation for understanding enms transformations in various environmental media
- Explore toxicity effects of the altered materials
- Develop a systematic and integrated approach to assess, manage and communicate risks associated with enms in environment.
- Work nationally and internationally to develop comprehensive research portfolio that addresses environmental and human health concerns.