



# Precautionary Regulation of Nanotechnologies

Jennifer Sass, Ph.D.

NRDC, Washington, DC

Email: [jsass@nrdc.org](mailto:jsass@nrdc.org)

# Nanotechnologies may result in large-scale social disruption...

“... comparable perhaps to the Industrial Revolution—but compressed into a few years. This has the potential to disrupt many aspects of society and politics... Weapons and surveillance devices could be made small, cheap, powerful, and very numerous... Overuse of inexpensive products could cause widespread environmental damage... There are numerous severe risks—including several different *kinds* of risk—that cannot all be prevented with the same approach.”

-Center for Responsible Nanotechnology (2006)

[www.crnano.org/dangers.htm](http://www.crnano.org/dangers.htm)

# Nanotechnologies and war

“The potential for NT innovations in chemical and biological weapons is particularly disquieting, as NT can considerably enhance the delivery mechanisms of agents or toxic substances. The ability of nanoparticles to penetrate the human body and its cells could make biological and chemical warfare much more feasible, easier to manage and to direct against specific groups or individuals.”

NATO Parliamentary Assembly Committee (2005)  
**179 STCMT 05 E - THE SECURITY IMPLICATIONS OF  
NANOTECHNOLOGY**

[www.nato-pa.int/Default.asp?SHORTCUT=677](http://www.nato-pa.int/Default.asp?SHORTCUT=677)



# Potential environmental, health, social & economic impacts

- NTs are predicted to reshape the world from the atom up
- This requires that we ask critical questions about purpose, predictability, ownership, risk and responsibility
- Yet the primary debate about nanotechnology is primarily limited to toxicity risks, ignoring broader implications
- Role for non-governmental organizations (NGO's), social scientists, ethicists, and civil society in a global dialogue to shape the potential future of NTs

# Problem: no regulatory oversight

- ◆ Must trigger a mass/vol threshold to trigger most regulation (TSCA, 10k kg/yr; OSHA, nuisance dust std 5 mg/cu.m)
- ◆ Burden on govt to prove harm; No data means no risk
- ◆ Reg's target chemical, not final use/product
- ◆ No detection equipment means no enforcement ability

# The Nano-Titanic has already left port

More than \$50 billion of nano-enabled products were sold worldwide in 2006;  
the US holds approximately 6,800 nanotechnology-related patents .

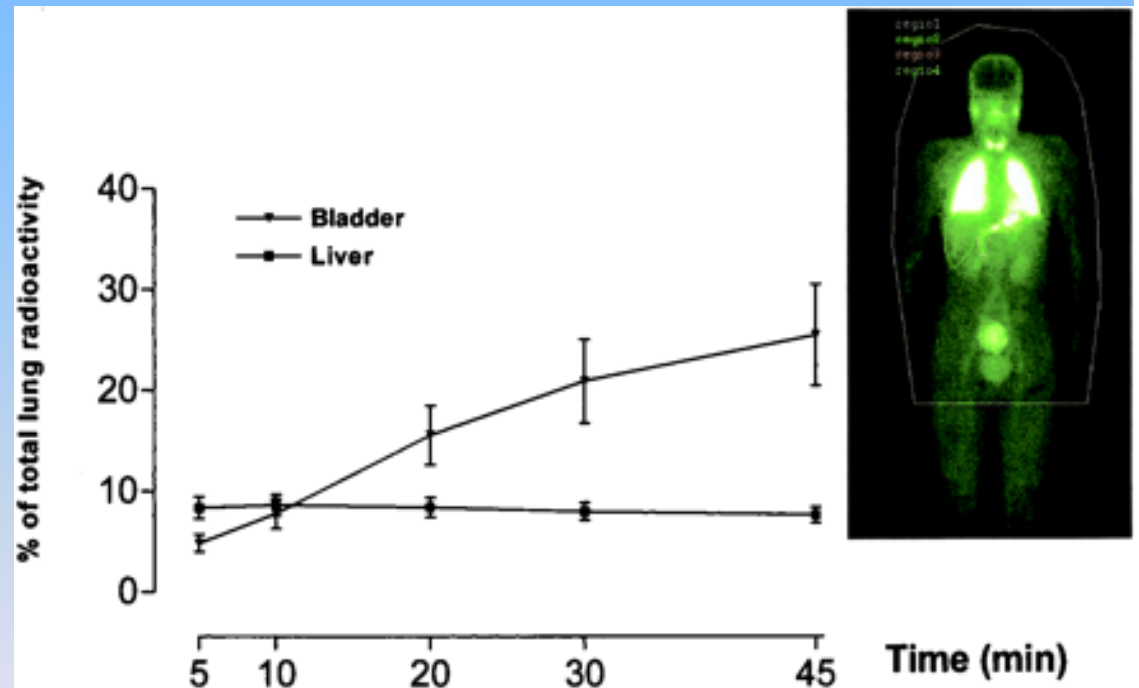
*Industry Week,  
May 2007*

Large corporations are embracing nanotechnology to drive product innovation



# EXPOSURE POTENTIAL

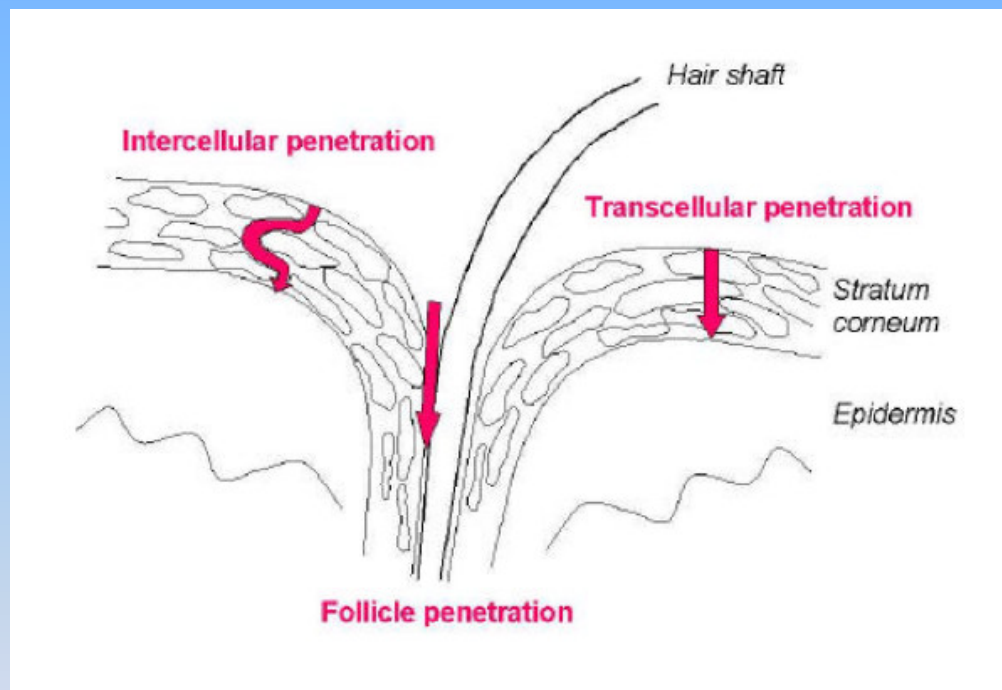
Inhaled nanomaterials have the potential to pass directly to the brain, and from the lungs into the blood stream.



Nemmar et al, 2001, 2002. (Reviewed in Borm PJ, Kreyling W: *J Nanosci Nanotechnol* 2004, 4:521-531)

Nano metal oxides in sunscreens may penetrate skin, though most tests on intact skin have reported only limited penetration.

Ingested nano materials pass from the gut into the blood stream.



Borm *et al.* *Particle and Fibre Toxicology* 2006 3:11

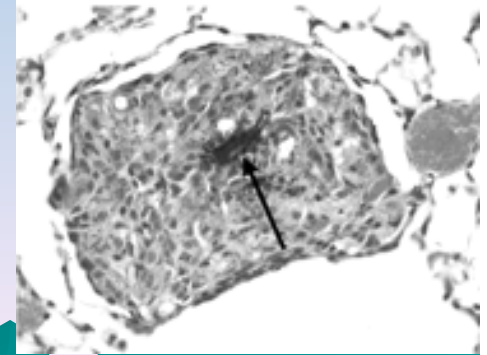
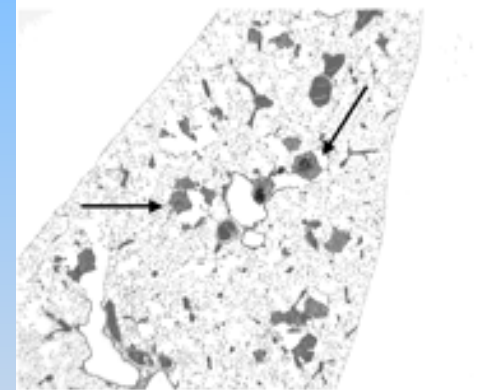
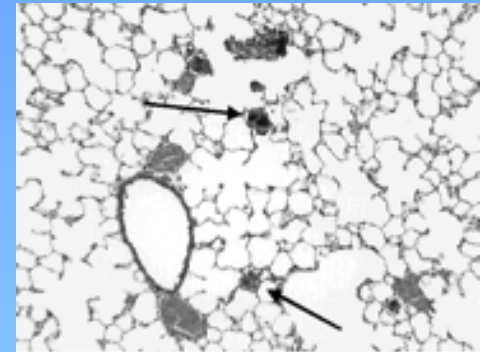
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# TOXICITY/HAZARD POTENTIAL

Instilled single walled carbon nanotubes induce progressive, irreversible lung damage and fibrosis in test rodents

1 mg/kg SWCNT led to fibrosis after 1 week

Warheit et al, Toxicological Sci **77**, 117-125 (2004).  
Reviewed in Oberdorster et al, Environ Health Perspect, 113(7) (2005)



# Nano-size air pollution is deadly

Ultrafine air pollution is linked to increased lung cancer, heart, and lung disease and death



Donaldson K, Tran L, Jimenez L, Duffin R, Newby DE, Mills N, *et al.*:  
Combustion-derived nanoparticles: A review of their toxicology following  
inhalation exposure 1. *Part Fibre Toxicol* 2005, 2:10

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# Nanomaterials may cause oxidative stress, inflammation, and cancer

Air pollution such as diesel soot, and nanoparticles such as carbon black and carbon buckyballs induce cellular oxidative stress

Since there is a clear link between oxidative stress and diseases including cancer, asthma and cardiovascular disease, by characterizing the oxidative stress profile of nanomaterials, we may be able to predict their toxicity

Xia et al, Nano Lett. 2006 Aug;6(8):1794-807. Reviewed in Stone and Donaldson, Nature Nanotechnology 1, (2006)



# Public concerns about risks

- Where should the burden of proof lie? Should we take a precautionary approach?
- Why should workers and the public accept poorly understood risks of nano-exposure?
- Are those most exposed to risk involved in the decision making process?
- Are scientists acknowledging the limits of the capacity to predict and manage risk?
- Are we developing risk management regimes that can cope with next generation nanotechnologies?

-G. Miller, Friends of the Earth, Australia  
Nov 2006, Tokyo

- ◆ **Prohibit the untested or unsafe use of nanomaterials.** Unsafe or untested nanomaterials should not be used in a manner that may result in human exposures or environmental releases over the lifecycle of the material.
- ◆ **Conduct full lifecycle environment, health, and safety impact assessments as a prerequisite to commercialization.** The results of testing should be made available to the public.
- ◆ **Facilitate full and meaningful participation by the public and workers in nanotechnologies development and control; consider the social and ethical impacts of nanotechnologies.** The potential of nanotechnologies to transform the global social, economic, and political landscape means we must move the decision-making out of corporate boardrooms and into the public realm.

# A good start....

EPA clarified that regulations for antimicrobials (under FIFRA) do apply to nanosilver. Unfortunately, companies like Sharper Image have already begun dropping the “nano” descriptors from its product packaging and website, without dropping nanosilver. (Wash Post, Nov 23, 2006)

Berkeley City Council unanimously supported an ordinance to amend its hazardous materials law to compel researchers and manufacturers to report what nanotechnology materials they are working with, any known EHS information, and how they are being handled. (Dec, 2006)

Cambridge City Council voted to consider a similar statute to the Berkeley ordinance (Boston Globe, Jan 26, 2007)

# INFORMATION RESOURCES:

NRDC (health and regulatory issues; May 07 report):

[www.nrdc.org/health/science/nano/contents.asp](http://www.nrdc.org/health/science/nano/contents.asp)

Friends of the Earth (health and social issues): <http://nano.foe.org.au/>

Environmental Defense (health and regulatory issues):

[www.environmentaldefense.org/issue.cfm?subnav=29](http://www.environmentaldefense.org/issue.cfm?subnav=29)

Wilson Center (information and searchable databases):

[www.nanotechproject.org](http://www.nanotechproject.org)

Rice Univ (science database): <http://icon.rice.edu/research.cfm>

NIOSH (worker health information):

<http://www.cdc.gov/niosh/topics/nanotech/>