

Nanomaterials and the Waste Stream

The Prevalence and Impacts of Nanosilver

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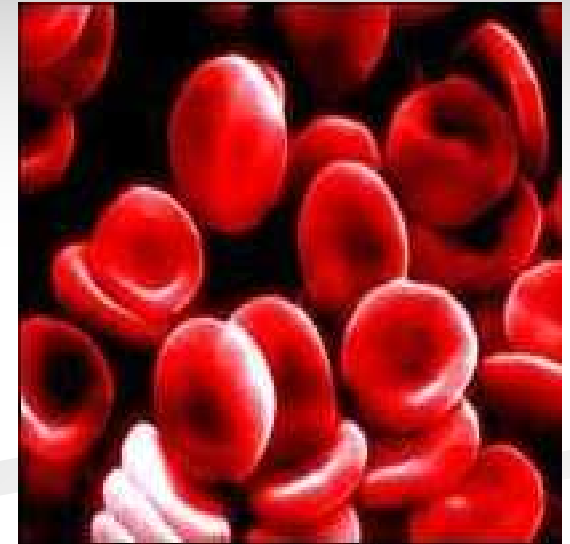
**The International Center for Technology Assessment
The NACWA 2009 National Pretreatment and
Pollution Prevention Workshop**



- ICTA is a Washington, D.C.-based non-profit, bi-partisan organization committed to providing the public with full assessments and analyses of technological impacts on society. CTA explores the environmental, human health, economic, ethical, social and political impacts that can result from the applications of technology or technological systems.
- ICTA's Nanotechnology Project: 2002-present

What is Nanotechnology?

- Nanotechnology involves the manipulation of materials and the creation of structures and systems that exist at the scale of atoms and molecules, nanometer (nm) scale.
- Engineered/manufactured nanoparticle: A *particle <100 nm* engineered or manufactured with a specific physicochemical composition and structure to exploit properties and functions associated with its dimensions and ***exhibits new or enhanced size-dependent properties compared with larger particles of the same material.***



- A nanometer (nm) = one billionth of a meter. Hair strand=80,000 nm; Red blood cell= 7,000 nm; DNA=2.5 nm.

Nano Prevalence

- The “gold rush” for nano-patents continues- USPTO issued more than ,400 nano-patents as of 2006, with 4,772 patent applications from US companies/institutions (Chen, et al. Trends in nanotechnology Patents. Nature Nanotechnology; Vol 3, 2008.)
- Nanotechnology research and development hit \$13.5 billion in 2007, up 14% from 2006. Global corporate R&D spending grew 23% to reach \$6.6 billion, passing government spending for the first time. (Industry Week, 2008).
- The shift in focus from R&D to commercialization has already been made in the marketplace. There was \$147 billion worth of nanotech-enabled products sold in 2007 (Lux Research, 2008)

Nano-Consumers

- Lux Research's *2008 Nanotechnology Report*: the global market for nanotechnology is expected to reach 3.1 trillion by 2015
- Wilson Center's *Project on Emerging Nanotechnologies* Consumer Product Database contains over 800 self-identified nano-products now on U.S. market shelves.
- 3-4 new products are introduced every week



Nano- Consumers: What they're buying and selling

- Underwear, socks, clothing
- Baby Bottles
- “Disinfectant sprays”
- Colloidal silver “health drinks”
- Face cleansers, personal care products
- Food storage containers
- Razors
- Pet supplies
- Inks and Printing supplies



(Photo by David Hawxhurst-Woodrow
Wilson International Center for Scholars.)

Many Products= Many ways to enter the environment

The Samsung Silver Washing Machine

- In 2006, Samsung began selling its SilverCare Washing Machine.
- "Through electrolization, 400 billion nano-sized silver ions are emitted, directly penetrating into fabrics during the wash and final rinse cycles, creating an amazing anti-bacterial and sterilization effect on clothes".



“ Imagine over 100 quadrillion silver ions dissolved in water to make a super cleaning solution.”

- Jeffrey Armstrong, Samsung's Sr. Marketing Manager for Laundry

Nano: Should we be concerned?

- Materials engineered or manufactured to the nano-scale exhibit different fundamental physical, biological, and chemical properties
 - Quantum physics effects
 - Exponentially increased surface area
- These new properties create unique and unpredictable human health and environmental risks
 - increased surface area creates increased reactivity and enhanced intrinsic toxicity
 - Size creates unprecedented mobility to human body and environment. Nanoparticles can cross biological membranes, cells, tissues and organs more efficiently than larger particles.

Nano Environmental Impacts

- Pathways: during manufacturing, transport, use, or disposal
 - e.g., nano-cosmetics or other nano-personal care products: washed off in the shower and join water waste streams, or washed off directly into rivers or lakes.
- Research: much more needed, but early studies indicate potential serious environmental impacts and point to urgent need for further study.



Nanosilver: Heal or Harm?

- Nearly 300 consumer products on the market containing nanosilver.
- Marketed as “antimicrobial”, “antibacterial”, “germ-killing”
- Increasing body of evidence suggesting nanosilver is potentially harmful to both the environment and human health
 - Potential ability to bioaccumulate
 - Demonstrated cellular dysfunctions and reproductive problems
 - Some evidence to suggest potential to increase antibiotic resistance



Nanosilver “Regulations”

- In November 2006, EPA stated they would regulate nano-silver products, after the introduction of the Samsung SilverCare Washing Machine, and would publish a proposed rule in the Federal Register
- EPA notice published nearly 1 year later in the Federal Register, did not mention “nano” at all, and proposed to regulate “ion generating” products
- Would only regulate those products that made explicit claims on germ-killing ability- created a large loophole



Nanosilver FIFRA petition

- May 2008: ICTA and coalition of consumer, health, and environmental groups file legal petition calling on EPA to regulate nano-silver as a pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
 - +270 nano-silver consumer products found
 - Nano-silver meets the FIFRA definition of “pesticide” because it is a highly efficient antimicrobial agent and is intended for that purpose
 - Pesticides require premarket review of potential harmful effects



Nanosilver FIFRA petition

Petition calls on EPA to, *inter alia*:

- Regulate nano-silver products as pesticides
- Classify as “new” pesticides
- Assess human health and environmental risks of nano-silver
 - *FIFRA, FQPA, ESA, NEPA*
- Prohibit sale of illegal nano-silver pesticides until or unless they are registered and are approved
- Require/amend regulations: nano-specific ingredient and warning labeling, data, and testing



Nanosilver FIFRA petition

- EPA opened a docket (EPA–HQ–OPP–2008–0650) for ICTA nanosilver petition on November 19, 2008 in Fed. Reg. (73 FR 69644).
- Original public comment period was for 60 days, but on January 14, 2008 in the Fed. Reg. (74 FR 2072) EPA granted an additional 60 days of comments which ended on March 20, 2009.
- More than 15,000 comments were submitted
- Still waiting on a decision

**In the meantime the evidence
continues to mount...**

Nanosilver Impacts

- Benn and Westerhoff (2008) demonstrated the potential impact of nanosilver-impregnated clothing to pollute waste streams, and particularly noted, “high silver concentration may limit the disposal of biosolids as agricultural fertilizer.”
- Choi et al. (2008) “results suggest that nitrifying bacteria are especially susceptible to inhibition by silver nanoparticles, and the accumulation of silver nanoparticles could have detrimental effects on the microorganisms in wastewater treatment.”
- Yang et al. (2009) found that food storage silver nanoparticles differentially compromised genes and DNA replication.



Conclusions

- More EHS Studies: Adequate, publicly available, independent, peer-reviewed safety studies on the environmental and health impacts of nanomaterials
 - Currently less than 5% of the total NNI budget is for EHS
- Learning from the past: Federal agencies charged with regulatory oversight must act quickly if it hopes to avoid repeating the mistakes of past failures (e.g., asbestos, CFCs, DDT, PCBs)
- Adequate Regulation: A regulatory framework is needed that protects workers, the general public and the environment from the impacts of nanomaterials throughout their lifecycle



Thank you!

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