

# CAUT Health and Safety Fact Sheet



## Nano Safety

ISSUE 20

Nanotechnology has been hailed as the newest and best in technology – the wave of the future. It is being rapidly incorporated into a diverse range of products like wrinkle and stain resistant fabrics, sunscreens, glare-resistant eyeglasses, sports equipment, medical uses, military applications, etc. Yet while being embraced because it makes things faster and simpler, nanotechnology's hazardous implications in and out of the workplace are just now being recognized.

The idea is that smaller is cheaper and safer – but ongoing research is raising startling discoveries that nano particles may be more dangerous than macro-particles. The recently released study by Dr. Ken Donaldson and colleagues from the University of Edinburgh, likens nanoparticle hazards to the danger posed by asbestos – very small particles that cannot be expunged by the body.<sup>1</sup>

The National Institute for Occupational Health and Safety has produced several documents on nanoparticles, and is collaborating globally on research regarding environmental and biological impact of its everyday use.

“The size of particle is directly linked to their potential for causing health problems,”<sup>2</sup> according to the US Environmental Protection Agency. When particles 10 micrometers or smaller in diameter are inhaled they can cause serious health effects, particularly in the heart and lungs.

CIELAP, the Canadian Institute for Environmental Law and Policy, notes that “...there is not formal regulatory or explicit public policy framework in Canada to manage the technology's risks and benefits. *There is also no mechanism that requires the government to inform and consult the public about it.*”<sup>3</sup>  
[emphasis added]

While emerging technologies can potentially create or transform industries, their development has far outpaced our understanding of their implications for occupational safety and health.<sup>10</sup>

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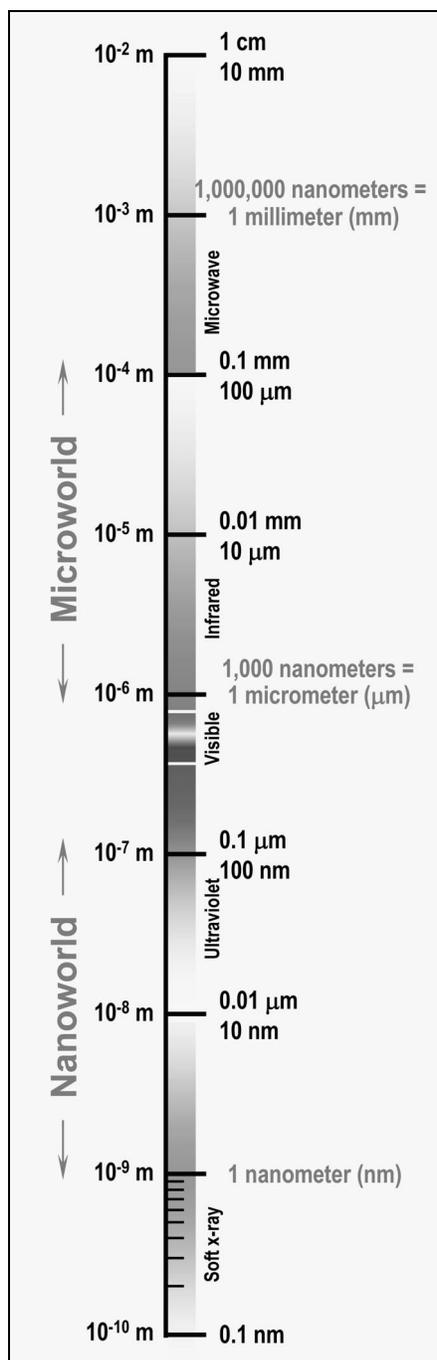
## What Is Nanotechnology?

It is most easily understood as the use of ultrafine particles – the ones emitted from photocopiers.

- It involves the manipulation of materials at the nanoscale of atoms and molecules.
- One nanometer is a billionth of a meter – a hundred thousand times smaller than the width of a human hair, and a thousand times smaller than a red blood cell.
- It uses the building blocks of chemical elements and compounds that make up all materials.
- Materials at this scale can have unusual properties that are different from the same substance's properties at the macro or micro scales. Colour, conductivity, elasticity, reactivity, strength, and other properties change in potentially useful ways.
- Nanotechnology is about developing ways to use and control these properties.

## Some Examples

- Genetically modified foods and food/beverage containers
- Clothing and car parts
- Wireless technology and cell phones
- Construction materials
- Pharmaceuticals and dietary supplements
- Delivering drugs to specific sites in the body
- Semi-conductors and insulators



*Scale of Things chart – developed by the Office of Basic Energy Sciences in the U.S. Department of Energy*

## Measuring

Although traditional industrial hygiene sampling can be used to measure airborne nanoparticles, the results are limited and require careful interpretation.

When sampling in the workplace, it should include: background measurements, and measurements before, during and after production or handling of nanoparticles.

## Safety and Health Hazards

Fire and explosion are the prime workplace safety hazards, due to physical and chemical properties arising from dustiness, combustibility, flammability and conductivity of nanomaterials.

Inhaling ultrafine particles can produce respiratory irritation, cardiovascular disease and cancer.<sup>4</sup>

It appeared that the use of silver nanoparticles (AgNPs), made environmentally contaminated drinking water safe by removing harmful bacteria. But a study done by Dr. Zhiqiang Hu at the University of Missouri-Columbia<sup>5</sup> has shown that while it is true that the silver nanoparticles kill harmful bacteria, they are toxic to the reproduction of good bacteria, essential to removing ammonia from wastewater treatment systems. It is common practice to use the sludge produced at these plants for landfill and fertilizer to grow food. This would also contaminate food products grown in this medium. Dr. Hu notes that AgNPs can be more toxic and generate more reactive oxygen species in the cell than silver ions.

A recent study in the Netherlands<sup>6</sup> – the first of its kind – published in Particle and Fibre Toxicology

indicates that functional changes in brain activity may also be caused by nanoparticle exposure. Participants showed a stress response from increased brain activity after only 30 minutes of exposure. This increased activity continued to rise during a one-hour, post-exposure interval. Although the authors acknowledge that further studies will be needed before definitive conclusions can be made, warning signs are being raised.

Until further information is available, the Centre for Disease Control states that caution needs to be exercised when potential exposure may occur.

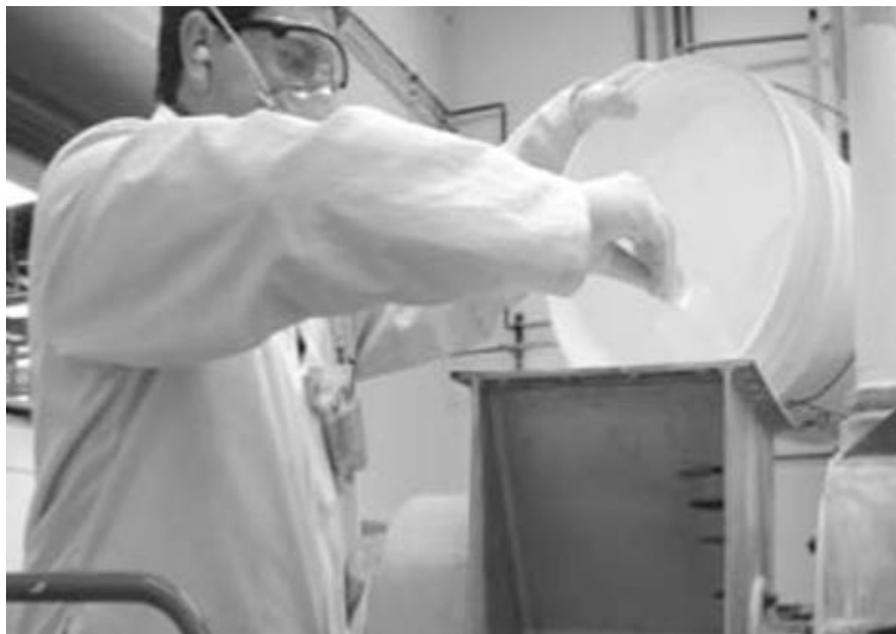
NIOSH highlights the “unintended consequences” of nanotechnology on physical and psychological health due to 24/7 work hours arising out of wireless communications.

## Exposure

There are three routes along which worker exposure can occur:

- Inhalation
- Ingestion by hand to mouth transference or swallowing particles
- Skin penetration may occur

The CDC notes that the concentration, duration and frequency of exposure, the ease with which nanoparticles can be dispersed as a dust, airborne spray or droplets, and the efficacy of engineering controls will all have an impact on exposure levels.<sup>7</sup>



*A nanoparticle production worker wearing a personal air sampler and hearing, respiratory, and dermal protection during a pouring operation.*

Handling of nanoparticles in powder form in non-enclosed systems is the greatest risk. Aerosols from slurries, suspensions or solutions pose inhalation and dermal hazards.

## Exposure Control

Nanotechnology is still too new to be thoroughly assessed as a hazard. However, using the precautionary principle as a base, some exposure controls can still be applied to known hazards:

- Source enclosure is important as dust, sprays and droplets can create fire and explosions
- Local exhaust ventilation systems with HEPA filters should be mandatory
- Protocols and controls used for welding fumes can be effective when working with nanoparticles<sup>8</sup>
- It is not yet known if masks are effective as Personal Protective

Equipment, and NIOSH is currently reviewing this

- N-95 and N-100 Respirators are designed to filter out particles at 300nm diameters, and NIOSH believes that they would provide sufficient protection from 1nm to 100nm particles

## Protocols

The European Trade Union Confederation (ETUC) says that the precautionary principle should be implemented with regards to nanotechnology until sufficient data can show no harmful effect on the human health and the environment.<sup>9</sup>

Concern for worker health in laboratory and manufacturing settings and consumer and environmental exposure is rising as the production and use of this technology is undergoing rapid growth.

## ETUC Resolution on Nanotechnology

- Adoption of a no data, no market policy
- Provision of training and health surveillance to exposed workers
- Provision of safety data sheets with full disclosure of nanomaterials
- Involvement of workers and their representatives in the assessment and reduction of nanomaterial-related risks
- Investment of a least 15% of public research budgets for health and environmental aspects
- Ensuring health and safety at work are a compulsory part of all research projects

## References

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## Notes

**1** Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study, www.nature.com, 20 May 2008; doi:10.1038/nnano.2008.111

**2** Particulate Matter, Air & Radiation, EPA

**3** Nanotechnology: a quickly emerging field promising benefits and significant risks, May 21, 2008, CIELAP

**4** Hutchison, S., Queensland University of Technology, Brisbane, Australia, August 2, 2007

**5** Choi, O.K., Hu, Z.Q. 2008. "Size dependent and reactive oxygen species related nanosilver toxicity to nitrifying bacteria." *Environ. Sci. Technol.* 42:4583-4588

**6** Short Report, Exposure to diesel exhaust induces changes

in EEG in human volunteers, Cruits et al, Particle and Fibre Toxicology, March 11, 2008

**7** Safe Nanotechnology in the Workplace – An Introduction for Employers, Managers and health and Safety Professionals, Centers for Disease Control and Prevention

**8** Safe Nanotechnology in the Workplace (same as 7)

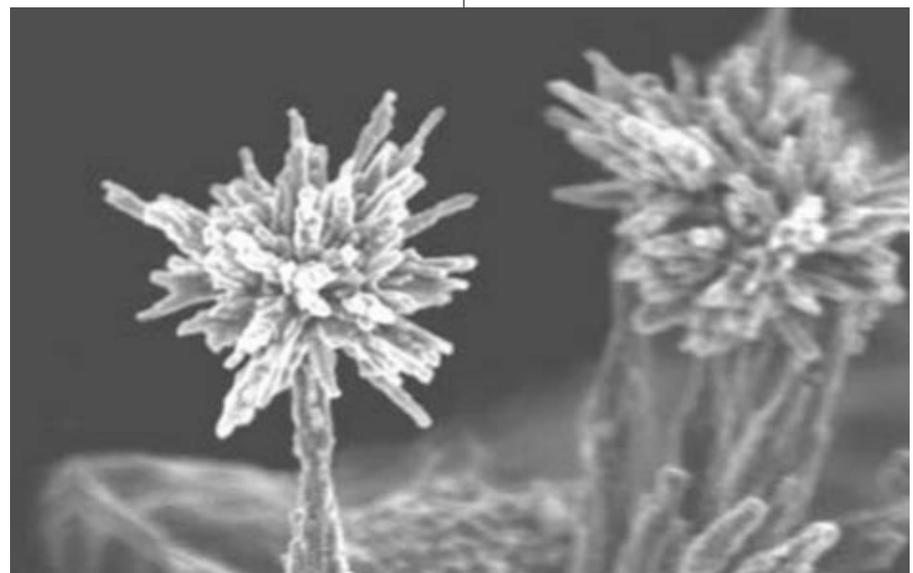
**9** Precautionary Principle Needed for Nanomaterials, What's News August 1, 2008, Workers Health and Safety Centre

**10** Emerging Technologies and the Safety and Health of Working People: Knowledge Gaps and Research Directions, CDC/NIOSH, Publication No. 2006-136

Photos

Page 1: © Jupiterimages Corporation

Pages 3 and 4: Nanotrees, Ghim Wei Ho and Professor Mark Welland, Nanostructure Center, University of Cambridge, Safe Nanotechnology in the Workplace, NIOSH



*Nanotrees – new structures from nanowires*