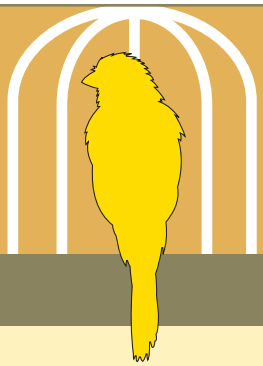
Nanomaterials

HEALTH AND SAFETY FACT SHEET

CUPE Canadian Union of Public Employees



What are Nanomaterials?

The term nanomaterial is generic for a diverse collection of smaller than microscopic materials. The Canadian Standards Association defines nanomaterial as a material with any external dimension in the nanoscale, or having an internal structure or surface structure in the nanoscale. That means one dimension (length, width or thickness) is between 1-100 nanometers.

Nanomaterials come in many forms, and can be made of any material, including metals, ceramics, polymers, or composite materials. While we normally think of nanomaterials as products of advanced science, (engineering nanomaterials) there are also some naturally occurring nanomaterials that are formed as the result of natural erosion, intense forest fires and volcanic activity. Nanoscience is research exploring the properties of nanomaterial behaviour, while nanotechnology is a term for research applying these new materials to make or enhance products.

How small is the nanoscale?

Centimetre (cm)	0.01 m
Millimetre (mm)	0.001 m
Micrometre (μm)	0.000001 m
Nanometre (nm)	0.000000001 m

The table above shows the size of a nanometre relative to a centimetre, but to get a true sense of the size, picture a carbon nanotube next to a human hair as about equivalent to putting a human hair next to a 4-lane highway. The width of a human hair is about 50,000 times thinner than the highway, and the width of a carbon nanotube is about 50,000 times thinner than the human hair.

Where do we find nanomaterials?

Nanomaterials are used in diverse ways. Some we might expect, like the latest computer chips and electronics, or new medical technologies and treatments. However, the application of nanomaterials in less obvious products is occurring as well.

New forms of insulation materials, improvements to cutting tools making them tougher and harder, and even ceramics that are stretchable and bendable are all new ways nanomaterials are being used.

Nanomaterials are in everything from cosmetics and sunscreen to paint and even vitamins. Other nanomaterials can be found in cleaners, food packaging, and sprays. Often they are used in the process of coating an existing product with a thin film of a nanomaterial to make it water-repellent, microbial repellent, scratch resistant, or to reduce glare or reflections.

Carbon nanotubes are being used to create lightweight, strong materials that are being used in sporting equipment and auto body parts. Silver nanoparticles can be found in some sports apparel and footwear because of antibacterial properties (so your workout clothing won't smell). The technology will likely soon affect the production of many things we come into contact with.

Are nanomaterials a hazard?

This is a difficult question to answer because not all nanomaterials are hazardous. Some new drugs take advantage of novel properties of nano-sized materials to increase delivery. However for most nanomaterials being produced and used in the workplace, there is not enough information about the properties of the material to be able to deem them safe. There are many properties of

nanomaterials that make them potentially more hazardous than their bulk counterparts including the shape, size, surface texture, and surface charge, which can impact how the nanomaterial might affect our health.

Size. The small size of nanomaterials means they can more easily pass into our bodies though our skin or inhalation. Once inside, nanomaterials can move through the human system in ways larger material cannot, and our body has no way to break down or remove these particles. Nanomaterials can pass though barriers to the brain or placental wall that other materials cannot.

Surface Area. Nanoparticles have a higher surface area in proportion to their mass. An increased surface area typically means the particle will be more reactive (such as having an increased biologic activity by mass when compared to larger particles).

Behavior. Many nanomaterials have different properties than their 'bulk' counterparts. Materials that are normally safe for humans could cause significant health impacts when manufactured on the nanoscale. For example, normal silver is a well-known material to many people. We generally know when and where it's safe and appropriate to use. Nano-sized silver particles behave differently. In its nano form, silver acts as a powerful antibacterial that has also been shown to damage human cells.[1] Much more research is needed to determine the effects of using nano-silver, and other nanomaterials so readily in our products.

Lack of regulation. The rapid advancement of nanomaterial application has greatly outpaced government's ability to regulate. There are no regulations to protect workers exposed to potentially harmful by-products of nanotechnology. There are no controls for nanopollution, caused by the breakdown of products containing nanoparticles in our landfills or water systems. Safety data sheets that are regulated by Workplace Hazardous Materials Information System do not have specific requirements to identify when a material ingredient is in a nano-sized form. As with many chemicals, it has become our responsibly as the workers exposed to prove that a product is a hazard, as opposed to a company showing that their products are safe before governments will act.

Protecting workers

Health and safety laws across Canada require employers to inform workers of hazards that are in the workplace that they may be exposed to. This requirement includes the introduction of new materials. If employers are bringing in new products that contain nanomaterials, workers who will be exposed must be informed so that the health and safety committees and representatives can discuss control measures and procedures with the employer.

At any workplace where products that contain nanomaterials are used, workers can be exposed through all stages of use. Workers may be exposed during processes for which nanomaterials are used, during the maintenance of equipment and machinery that contain or could be covered in excess material, as well as during clean up.

A simple example of this muliti-level potential exposure can be seen at a university where CUPE members are working with nanomaterials in a research lab. If the exhaust system is not adequate, or malfunctions, the researcher may be exposed. If the machinery (i.e. a fume hood) requires repairs, then maintenance staff may be exposed while performing maintenance. Finally, cleaning staff may be exposed if the material has not been properly disposed of, or if there has been a spill.

What protections are needed?

As with any potential exposure at the workplace, the protections will depend on a number of factors including[2]:

- **Characteristics of the material**
  More hazardous material require tighter controls to prevent exposure.
- **Amount of the material**
  If there is a lot of material being used or transported, additional controls may be necessary.

- **Whether the particles are dry, in a solution or contained within a solid material**
  Powders are more likely to become airborne, however liquids that are improperly cleaned will also be likely to become airborne once they dry. Additionally, solid materials may release nanomatials if they are grinded. As such, control measures must take into account what the materials' properties are, and how it will be used.

- **Degree of containment**
  The type of engineering controls used to contain a material will determine if additional controls are necessary.

- **Duration of use**
  The longer a worker is exposed to a hazard, the larger the dose of the hazard that may be absorbed into the body, so control measures for extended use may be different than those for short duration activities.

Due to the extremely small sizes of nanomaterials, classical methods of determining toxicity of a product may not be accurate as many studies have determined that the toxicity of particles increase when there is a decrease in diameter size and an increase in the surface area.

In workplaces where nanomaterials are being used, the **precautionary principle** should be applied, and exposure to workers prevented until sufficient data can show there are no harmful effects on human health or the environment. Due to the small size, normal personal protective equipment may not be sufficient to protect from exposure to nanomaterials.

The precautionary principle states that when there is a chance of serious harm, the absence of full scientific certainty should not be used as a reason for postponing the implementation of protective measures.

When planning for control measures for nanomaterials, health and safety committees should consider the hierarchy of controls.

1. Elimination (including substitution)
If the nano-form of a material is not needed, then use the bulk form, or a different product that is safer.

2. Engineering controls
If the nanomaterial cannot be removed, exposures should be controlled by the use of equipment that prevents the workers from coming into contact with the materials such as a negative pressure fully enclosed glove box with an exhaust ventilation system and a high-efficiency particulate air (HEPA) filter.

3. Administrative controls
Set rules and procedures for safe use when the above control methods are not options. Separate rooms for office work and laboratory work as well as change facilities and designated 'non-nano' rooms for eating are examples. Education and training in safe handling is essential, regardless of other controls.

4. Personal protective equipment (PPE)
PPE must be used as a last resort, and caution must be applied as many forms of PPE, such as fit-tested respirators, regardless of type, are currently being studied to determine which, if any, offer protection from nanoparticles.

As part of a broader strategy, CUPE has called on both government and industry to establish a clear, top down research strategy for new nanotechnology-enhanced products. Governments need to determine how nanomaterials should be regulated, and companies need to be held legally responsible if their new products harm workers, end users, or the environment.

[1] You, C, Han, C, Wang, X et al. 2012 The Progress of Silver Nanoparticles in the Antibacterial Mechanism, Clinical Application and Cytotoxicity. Molecular Biology Reports 39(9): 9193–9201.

[2] www.ccohs.ca/oshanswers/chemicals/nanotechnology.html

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