HARVARD
Campus Services
ENVIRONMENTAL HEALTH & SAFETY

Nanomaterial Safety

What are Nanomaterials?

Nanomaterials or nanoparticles are human engineered particles with at least one dimension in the range of one to one hundred nanometers. They can be composed of many different base materials (carbon, silicon, and various metals).

Research involving nanomaterials ranges from nano-particle synthesis to antineoplastic drug implants to cell culture work. Material Scientists, Chemists, Biologists, Biochemists, Physicists, Microbiologists, Medical-related disciplines and many engineering disciplines (Mechanical, Chemical, Biological and Environmental, etc.) perform research using nanomaterials.

Naturally created particles of this size range are normally called ultra-fine particles. Examples are welding fumes, volcanic ash, motor vehicle exhaust, and combustion products.

Nanomaterials come in many different shapes and dimensions, such as:

- 0-dimensional: quantum dots
- 1-dimensional: nanowires, nanotubes,
- 2-dimensional: nanoplates, nanoclays
- 3-dimensional: Buckyballs, Fullerenes, nanoropes, crystalline structures

Nanoparticles exhibit very different properties than their respective bulk materials, including greater strength, conductivity, fluorescence and surface reactivity.

Health Effects

Results from studies on rodents and in cell cultures exposed to ultrafine and nanoparticles have shown that these particles are more toxic than larger ones on a mass-for-mass basis.

Animal studies indicate that nanoparticles cause more pulmonary inflammation, tissue damage, and lung tumors than larger particles

Solubility, shape, surface area and surface chemistry are all determinants of nanoparticle toxicity

There is uncertainty as to the levels above which these particles become toxic and whether the concentrations found in the workplace are hazardous

Respiratory Hazards:

- Nanoparticles are deposited in the lungs to a greater extent than larger particles
- Based on animal studies, nanoparticles may enter the bloodstream from the lungs and translocate to other organs and they are able to cross the blood brain barrier.

Dermal Hazards:

- Some studies of quantum dots applied to the intact skin of animals indicate that nanoparticles can penetrate the skin
- Research in vitro of the cellular effects of skin penetration indicate some damage to cellular function, but it is unclear if these findings can be extrapolated to occupational exposure

Ingestion Hazards:

- Little is known about the possible adverse health effects from ingestion of nanoparticles, but prudence calls for avoiding hand to mouth contact

Inhalation Exposure Control Methods

Nanoparticles will follow airstreams so they can be easily collected and retained in standard ventilated enclosures such as fume hoods and biosafety cabinets with HEPA filters.

- Synthesis in enclosed reactors or glove boxes will prevent airborne exposures.
- Inhalation exposures can occur when processing materials are removed from the reactors. These activities should be performed in fume hoods and, where practicable, those with HEPA filters such as biosafety cabinets.
- Maintenance on reactor parts that might cause the release of residual particles should be performed in a fume hood and, where practicable, a hood with a HEPA filter such as a biosafety cabinet.
- Work with nanomaterials in solution form should be carried out in a fume hood or, where practicable, in a hood with HEPA filters.
- Research techniques should stress slow and careful handling of the material to prevent aerosolization.

Dermal Exposure Control Measures

Some research suggests that nanoparticles are able to penetrate intact skin is so gloves should be worn when handling particulates or particles in solution.

- For liquids, the glove should have good chemical resistance to the solute.
- For dry particulate, a sturdy glove, such as nitrile lab gloves with good integrity, should be used.
- Disposable nitrile lab gloves should provide good protection for most lab procedures that don't involve extensive skin contact. If contact is extensive, then double-gloving should be practiced.
- There should be no exposed skin around the hands and wrists.
- Check gloves regularly for holes, cracks, etc.
- Wash hands immediately after removing gloves.

Ingestion Control Measures

Follow normal hygienic principles:

- Scrupulously avoid hand-to-mouth contact.
- Wear gloves at all times where there is potential for exposure to nanoparticles.
- Wash hands immediately after removing gloves.
- No eating, drinking, smoking, applying cosmetics, etc. in the lab or before hands are washed.

Injection Control Measures

Follow laboratory sharps minimization work procedures.

Cleanup

- Use dampened cloths to wipe up powders.
- Apply absorbent materials suitable for the solute to large liquid spills.
- Dry sweeping or using compressed air are never appropriate cleanup methods.
- Use a HEPA-filtered respirator and double gloves when cleaning up large spills

Disposal

- Never dispose of nanoparticle waste in regular trash or down the drain.
- When disposing of dry nanoparticle waste, use a sealable container that remains closed.
- Dispose of all nanoparticle waste, including contaminated debris, as you would the base material (i.e., carbon nanotubes should be disposed of as carbon, metallic particles consistent with the base metal.)
- If the nanoparticles are in solution, they should be managed as a solution of the solvent and the parent nanomaterial (e.g., flammable solvents are handled as flammable waste materials).
- All nanoparticle waste must be labeled with the base metal or solute and identified as containing nanomaterial.
- Proper disposal of nanoparticle waste will be based on the type of material and will be coordinated through our waste disposal contractor.

Contact your lab safety officer or call EH&S at 617-496-3797 if you are planning to work with nanomaterials and would like assistance with appropriate engineering control selection, procedure development, or disposal procedures.