3.18. Nanotechnology Safety Procedures

Nanomaterials are defined as ultrafine particles with a dimension of one to 100 nanometers in diameter. One nanometer is one-billionth of a meter.

Low-solubility ultrafine particles are more toxic than larger particles on a mass-for-mass basis. In addition to the hazardous properties of the chemical constituents, their smaller dimensions, larger surface area, and ability to penetrate cell membranes more easily than larger particles add to the hazardous properties of these materials.

Because of their small particle size, they can be deposited deep into the lungs and, once in the bloodstream, may be able to cross the blood-brain barrier. Exposure to these materials during synthesizing processes and use may occur through inhalation, ingestion, and contact with the skin or eyes.

Other hazards to consider are catalytic effects and fire or explosion. Particles in the nanometer size range are currently being evaluated for toxicity and critical exposure levels based on mass, surface area, and the number of particles per unit volume. Until these factors are determined, implement stringent controls on exposure when working with them.

The following guidelines, modified from the American Chemical Society, are provided to educate and protect those working with nanomaterials.

3.18.1. Lab Safety Guidelines for Handling Nanomaterials

- Use good general laboratory safety practices as found in the Laboratory Safety and Chemical Hygiene Plan.
- Wear gloves, lab coats, safety glasses, face shields, and closed-toed shoes. Be sure to consider the hazards of precursor materials in evaluating process hazards. OSHA's "Particularly Hazardous Substances" (such as cadmium) must be handled in a containment such as a fume hood or a glove box.
- Avoid skin contact with nanoparticles or nanoparticle-containing solutions by using appropriate personal protective equipment. Do not handle nanoparticles with your bare skin.
- If it is necessary to handle nanoparticle powders outside of a HEPA-filtered powered-exhaust laminar flow hood, wear appropriate respiratory protection. The appropriate respirator must be selected based on professional consultation with IUEHS from your respective campus. Refer to the IU Respiratory Protection Program for additional information.
- Use fume exhaust hoods to expel fumes from tube furnaces or chemical reaction vessels.
- Dispose of and transport waste nanoparticles according to the hazardous chemical waste guidelines.
- Vacuum cleaners used to clean up nanoparticles must be factory tested, HEPA-filtered units.
- Equipment previously used to manufacture or handle nanoparticles should be evaluated for potential contamination prior to disposal or reuse for another purpose.
- Lab equipment and exhaust systems should also be evaluated prior to removal, remodeling, or repair.
- Given the differing synthetic methods and experimental goals, no blanket recommendation can be made regarding aerosol emissions controls. This should be evaluated on a case by case basis.
- Consideration should be given to the high reactivity of some nanomaterials with regard to potential fire and explosion hazards.