

# Standard Operating Procedure

## Nanoparticles

### Instructions

**This SOP template is incomplete until all the following steps are finished:**

1. Enter lab-specific information in the designated box.
2. Add the lab protocol or procedure in the Protocol/Procedure section.
3. Obtain signatures and dates from the PI and relevant lab personnel.
4. After completion, print a copy and place it in your Lab-Specific Chemical Hygiene Plan.

### Section 1: Lab-Specific Information

**Building/Room(s) covered by this SOP:**

**Department:**

**Principle Investigator:**

**Principle Investigator Signature:**

### Section 2: Physical Properties

The ASTM Committee on Nanotechnology has defined a nanoparticle as a particle with lengths in two or three dimensions between 1 and 100 nanometers (nm). Nanoparticles can be composed of many different base materials and may be of different shapes including: nanotubes; nanowires; and crystalline structures such as fullerenes and quantum dots<sup>1</sup>. The physical state of nanoparticles can be powder, suspension, or solid matrix.

### Section 3: Hazards

The primary routes of exposure for nanoparticles are inhalation, dermal absorption, and ingestion. Nanoparticles or nanomaterials used in laboratory experiments will likely be in one of three forms: a powder, in suspension, or in a solid matrix. The form of the nanoparticles or nanomaterial will play a large role in the exposure potential. For example, a nanoparticle in powdered form will present a larger inhalation hazard potential than a nanoparticle in suspension. Once inhaled, nanoparticles can deposit within the lung tissue, potentially causing lung function decrements and obstructive and fibrotic lung diseases, or translocate through the vascular and/or nervous system to other regions of the body, including the brain<sup>2</sup>.

Some common tasks that present some potential for exposure include:

- Working with nanoparticles in suspension without gloves;
- Working with nanoparticles in suspension during pouring or mixing where agitation is involved;
- Generating nanoparticles in the gas-phase;
- Handling nanoparticle powders;

- Maintenance on equipment used to produce nanoparticles;
- Cleaning up spills or waste material;
- Cleaning dust collection systems; and
- Machining, sanding, grinding or mechanically disturbing nanomaterial which can generate an aerosol.

## Section 4: Exposure Controls

The established hierarchy of exposure controls for nanoparticles is consistent with existing exposure control options for hazardous chemicals. The exposure control methods are summarized in Table 1.

**Table 1\*: Exposure Control Methods**

Control Method	Process, Equipment, or Job Task
Elimination	Change of Experimental Design to Eliminate the Hazard
Substitution	Substitution of a High Hazard with a Lower Hazard (chemical)
Engineering	Isolation/enclosure, Ventilation (Fume Hood)
Administrative	Work Practice Procedures, Chemical Hygiene Plan Policies
Personal Protective Equipment (PPE)	Gloves, Goggles, Clothing, Respirators

\*Table adopted from NIOSH document entitled, “Approaches to Safe Nanotechnology<sup>2</sup>”

Each of the control methods should be evaluated prior to beginning work on any project involving nanoparticles. The evaluation should include the completion of a hazard assessment. Forms to document the hazard assessment are available on the EHS website at [purdue.edu/operations/ehs/forms/](http://purdue.edu/operations/ehs/forms/). The ideal control method involves the elimination of the hazard (i.e. automated process which eliminates occupational exposure potential), or the substitution of a less hazardous material. If the hazards associated with a specific nanoparticle research project cannot be controlled with elimination or substitution, the following control options should be considered.

### Engineering Controls:

As previously discussed, the physical form of the nanoparticle will greatly influence the exposure potential. The inhalation exposure risk increases from nanoparticles in a solid matrix to nanoparticles in suspension to aerosolized nanoparticles. Additional factors that will influence the exposure risk include the quantity of material used or generated and the frequency and duration of exposure. Engineering controls that should be considered for use in laboratory scale nanoparticle research projects include source enclosure/isolation and local exhaust ventilation systems. Projects or processes involving the generation of nanoparticle aerosols and nanoparticles in suspension should be performed in a chemical fume hood, externally ducted biological safety cabinet, or glove box to limit the inhalation exposure potential. Chemical fume hoods must be approved and certified by EHS and have a face velocity between 80 – 125 feet per minute.

### Administrative Controls:

Administrative controls that should be considered and/or implemented during a laboratory scale nanoparticle research project focus on employee training and proper work procedures. Some administrative controls that should be considered include:

- Providing known information to workers and students on the hazardous properties of the nanomaterial precursors or products;
- Education of workers and students on the safe handling of nanomaterials;

- Restricting access to areas by using signs or placards to identify areas of nanoparticle research;
- Transport dry nanomaterials in closed containers;
- Handle nanoparticles in suspension on disposable bench covers;
- Always perform nanoparticle aerosol generating activities in a fume hood, externally ducted biological safety cabinet, or glove box; and
- Clean the nanomaterial work area daily at a minimum with a HEPA-vacuum or wet wiping method.

#### **Hygiene Measures:**

Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

#### **Hand Protection:**

Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. Use proper glove removal technique to avoid skin contact.

#### **Eye Protection:**

ANSI approved properly fitting safety glasses or chemical splash goggles are required.

#### **Skin and Body Protection:**

Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Wear commercially available arm sleeves in situations where dermal contact with nanoparticles in powders or in suspensions is expected. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

#### **Respiratory Protection:**

Nanoparticles should be in conjunction with proper engineering controls, such as a chemical fume hood or glove box. However, if nanoparticles must be used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact EHS (765-494-6371) so a respiratory protection analysis can be performed.

## **Section 5: Special Handling and Storage Requirements**

- Avoid contact with skin, eyes, and inhalation.
- Avoid handling nanomaterials in the open air in a “free particle” state.
- Store dispersible nanomaterials, whether suspended in liquids or in a dry particle form in closed containers whenever possible. Store in a cool, dry, and well-ventilated area.
- Clean up the work area at the end of each work shift; at minimum, using either a HEPA-filtered vacuum cleaner or wet wiping methods. Dry sweeping or air hoses should not be used to clean work areas. Cleanup should be conducted in a manner that prevents worker contact with nanomaterials.

## **Section 6: Spill and Accident Procedures**

All spills involving nanoparticles should be treated like a hazardous material spill and cleaned up immediately. Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If the spill is minor and does not pose a threat to

personnel, contact EHS at 765-494-0121 during normal business hours (7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 7: Waste Disposal Procedures

Since the toxicology and environmental fate of nanoparticles is still largely unknown, all nanoparticle waste (solid material and liquids) should be conservatively managed as hazardous waste. This also includes any debris (i.e. PPE, plastic) that has become heavily contaminated with nanoparticles. All nanoparticle waste must be placed in an appropriate container and labeled. The label should indicate all constituents in the waste using a percent format; nanoparticles can be listed as “trace”. Complete a Chemical Waste Pickup Request Form to arrange for disposal by EHS; detailed instructions are provided at the following link: [purdue.edu/operations/ehs/hazardous-waste-materials/hazardous-waste/disposal/](http://purdue.edu/operations/ehs/hazardous-waste-materials/hazardous-waste/disposal/).

## Section 8: Protocol (Add Lab Specific Protocol Here)

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

## References

1. ASTM E2456-06, “Standard Terminology Relating to Nanotechnology.
2. NIOSH [2009]. Approaches to Safe Nanotechnology. Managing the Health and Safety Concerns Associated with Engineered Nanomaterials. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. [www.cdc.gov/niosh/docs/2009-125/].

