Engineered Nanomaterials

Standard Operating Procedure

Revision Date: 05/12/22

This standard operating procedure (SOP) outlines the handling and use of engineered nanomaterials. Review this document and supply the information required in order to make it specific to your laboratory. In accordance with this document, laboratories should use appropriate controls, personal protective equipment, and disposal techniques when handling nanomaterials.

# Description [Provide additional information as it pertains to your research protocol]

Engineered nanomaterials (nanomaterials) are chemical substances or materials that are engineered with particle sizes between 1 to 100 nanometers in at least one dimension.  They are intentionally produced and designed with very specific properties related to shape, size, surface properties, and chemistry. Nanomaterials can be reagents, catalysts, or the desired product of research. Hazard characterization is often difficult because of high diversity in both the chemical components, physical state and particle geometry of nanomaterials. Use of nanomaterials must be documented by filling out the [Environment, Health & Safety Engineered Nanomaterial Survey](https://docs.google.com/a/umich.edu/forms/d/e/1FAIpQLScUHLDeC0J0ZN_A6o-qjt_IYqQR2MOc4A37nBEfesntrYRFSQ/viewform?formkey=dE5lWnhqWWR3MlNydl9NVmhubmhkYWc6MQ):

<https://docs.google.com/a/umich.edu/forms/d/e/1FAIpQLScUHLDeC0J0ZN_A6o-qjt_IYqQR2MOc4A37nBEfesntrYRFSQ/viewform?formkey=dE5lWnhqWWR3MlNydl9NVmhubmhkYWc6MQ>

## Process [Write the steps for using the chemical in your research protocol]

# Potential Hazards [Provide additional information as it pertains to your research protocol]

Be aware that toxicity of nanomaterials may be greater than for the parent material, and that their greater surface area may make nanomaterials more flammable, explosive or reactive than larger materials of the same composition. The risks of fire/explosion/reaction increase with the amount of nanomaterial; researchers should bear this in mind if scaling up a process.

Although insufficient information exists to predict the health hazard posed by the exposure to nanomaterials, current research indicates that exposure via inhalation, ingestion and skin contact can result in these materials entering the body. Results from human and animal studies show inhaled nanomaterials can deposit in the respiratory tract. Animal studies also show nanomaterials can enter the bloodstream and translocate to other organs. Nanomaterials have the greatest potential to enter the body if they are in the form of individual materials, agglomerates of nanomaterials, and materials from nanostructured materials that become airborne or come into contact with the skin.

According to [NIOSH](http://www.cdc.gov/niosh/) the following workplace tasks may increase the risk of exposure to nanomaterials:

* Working with nanomaterials in liquid media without adequate skin protection (e.g., gloves) will increase the risk of skin exposure.
* The following activities can increase the likelihood of aerosolization of nanomaterials, posing a potential risk of inhalation:
	+ Working with nanomaterials in liquid media during pouring or mixing operations, or where a high degree of agitation is involved;
	+ Generating nanomaterials in the gas phase in non-enclosed systems;
	+ Handling nano structured powders outside of a fume hood or other exhausted enclosure;
	+ Maintenance on equipment and processes used to produce or fabricate nanomaterials;
	+ Cleaning of dust collection systems used to capture nanomaterials.

# Engineering Controls [Provide additional information as it pertains to your research protocol]

Labs that handle nanomaterials must have non-recirculating general ventilation systems (100% exhaust air) with ventilation rates of 8-10 air changes per hour. Lab pressurization must be negative to the hallway.

Activities that are likely to release nanomaterials (such as the opening and emptying of reactors, borosilicate tubes, weighing of dry nanomaterials) shall not be performed on the open bench. These activities shall be performed in a fume hood (or other vented enclosure), biological safety cabinet, glove box or a vented filtered enclosure.

Handle dry nanomaterials in a fume hood, biological safety cabinet, glove box or a vented filtered enclosure. Do not work on the open bench with dry nanomaterials.

Aerosol producing activities (such as sonication, vortexing and centrifuging) may not be conducted on the open bench. Perform these activities in a fume hood, biological safety cabinet, glove box, or a vented filtered enclosure.

Exhaust from all furnaces used to produce nanomaterials must be trapped and connected to a local exhaust source. If aerosols may be produced, nanomaterials (and any suspensions of nanomaterials) must be handled in a chemical fume hood, exhausted biological safety cabinet with negative pressure ductwork, or other exhausted enclosure. Aerosols may be produced during any open handling of dry powder, and during open or pressurized manipulations of suspensions.

Controls beyond those described above are warranted when aerosol generation of nanomaterials will be extensive, or will involve acutely hazardous parent materials or tubular or fibrous-shaped nanomaterials. These controls might include a higher level of containment and/or HEPA-filtration or other cleaning of exhaust. For assistance with risk assessment, contact Environment, Health & Safety (EHS) at (734) 647-1143.

For a detailed discussion of risk assessment for work with nanomaterials, see Paik, SY, et al. (2008) Application of a Pilot Control Banding Tool for Risk Level Assessment and Control of Nanoparticle Exposures. Annals Occup Hygiene 52(6), 419-428.

# Work Practice Controls

* Prohibit the storage or consumption of food or drink in areas where nanomaterials are handled.
* Prohibit the application of cosmetics in areas where nanomaterials are handled.
* Require personnel to wash hands before leaving the work area and after removing protective gloves.
* Require lab coats to remain in the lab where the work is performed.
* Avoid touching the face or other exposed skin when working with nanomaterials.
* Change gloves regularly (at least every two hours) and wash hands at the time of the glove change.

## Workspace

* Set up a designated area for work with nanomaterials and suspensions away from entrances and high traffic areas.
* Post signs indicating hazards, personal protective equipment requirements, and administrative control requirements at entry points into designated areas where nanomaterials are handled.
* A designated area may be an entire laboratory, a section of a laboratory, or a containment device such as a laboratory hood or glove box.

## Labeling

Label all containers used to store nanomaterials with particle size to indicate that the contents are in nanoscale form. If the nanomaterial is in the form of dry dispersible particles, add the following line of text: “Nanomaterials can exhibit unusual reactivity and toxicity. Avoid breathing dust, ingestion, and skin contact.”

## Transferring

* Transport dry nanomaterials in closed containers. Handle solutions containing nanomaterials over disposable bench covers.
* Transfer nanomaterial samples between workstations (such as exhaust hoods, glove boxes, furnaces) in closed, labeled containers.
* If when weighing dry powders the balance cannot be located in a fume hood or BSC:
	+ Tare a container
	+ Add the material to the container in a hood
	+ Seal the container before returning to the balance to weigh the powder.

## Cleaning

**NOTE**: Dry sweeping or using compressed air are prohibited for cleaning areas and equipment contaminated with nanomaterials.

* Clean areas where nanomaterials are prepared and/or administered immediately following each task and each day after work with the nanomaterials is complete.
* Use wet wiping or HEPA vacuuming to clean large surfaces (i.e. floors, benches).

**NOTE**: HEPA vacuuming is not recommended for reactive materials, as they may react with other materials collected in the vacuum, or with components of the vacuum itself.
* Daily vacuuming of benches and floors with a HEPA vacuum should be performed in labs that handle dry nanomaterials.
* Using wet methods, routinely clean containment device interiors, equipment, and laboratory surfaces where there is potential for nanomaterial contamination. Consider the potential for complications due to the physical and chemical properties of the material to avoid reactions with cleaning agents.

## Shipping Nanomaterials

* Complete dangerous goods declaration or shipping papers for offsite shipments of nanomaterials in accordance with the IATA and DOT regulations. Contact EHS for instruction on shipping potentially hazardous materials.
* Materials sent offsite must also include a prepared document that describes known and suspected properties likely to be exhibited and notification of potential hazards. The institution may be required to create a Safety Data Sheet (SDS) for the material.

# Maintenance

* If using a HEPA vacuum, change the filter inside a chemical fume hood or biological safety cabinet. If the HEPA vacuum may be used for incompatible materials, maintain a log of vacuum use so that collection of incompatible materials can be avoided. Keep containers closed as much as possible.
* Notify applicable personnel of potential hazards before removing, remodeling, servicing, maintaining, or repairing laboratory equipment and exhaust systems used for nanomaterial research. The EHS laboratory equipment decontamination form must be completed.
* Wet cleaning or HEPA vacuuming of lab equipment and exhaust systems is required prior to repair, disposal or reuse.

# Personal Protective Equipment [Provide additional information as it pertains to your research protocol]

Fully buttoned lab coats must be worn. Lab coats may not be taken to private homes and laundered; they must be laundered via an approved laundry. U-M Procurement Services has a contract with Morgan Services, to provide laundering of Lab Coats & scrubs, the rental or purchase of Lab Coats, Scrubs, and Flame Resistant (FRC). Sleeve covers are required where high levels of exposure or splashes of solutions containing nanomaterials are anticipated. Gloves (disposable nitrile) must be worn when handling nanomaterials. Because skin penetration is a concern gloves must cover the wrist and any skin on the arm exposed by the lab coat. Appropriate personal clothing is required in all laboratories including those that work with nanomaterials. Long pants and closed toed shoes are required.

If splashes may occur, wear goggles and a face shield. Otherwise, wear standard laboratory safety glasses. In cases where the arms or torso may be exposed to liquid suspensions or dry materials, wear Tyvek sleeves and/or gowns (or other air-tight non-woven textile).

Respirators may be required for activities that cannot be controlled using ventilation. The need for, and selection of respirators, is the responsibility of EHS. All respirators users will comply with the University’s [Respirator Protection Program.](http://ehs.umich.edu/wp-content/uploads/2016/05/RespiratoryProtection.pdf)

Offices and general-purpose workstations may not be located inside laboratories that handle nanomaterials. Hand washing must be performed after handling nanomaterials and before leaving the lab.

# Transportation and Storage [Provide additional information as it pertains to your research protocol]

* Nanomaterials must be in sealed shatter-resistant containers during transportation. If the container is not shatter-resistant, use a secondary container.
* Containers must be labeled with nanomaterial name (or composition) and approximate particle size, along with any known hazard warnings.
* If the material may be flammable, reactive, or explosive, keep away from heat and open flame.
* Keep these powders away from any incompatible materials. (List any specific incompatibles.)

# Waste Disposal [Provide additional information as it pertains to your research protocol]

* All solutions and solid materials must be disposed of as hazardous waste following established University guidelines. As a prudent measure, manage nanoparticle wastes, including contaminated lab debris, as a part of your normal laboratory hazardous waste stream.
* Disposal of contaminated cleaning materials must comply with hazardous waste disposal policies.
* Spills of dry nanomaterials must be cleaned with a HEPA vacuum or, if appropriate, use moist sorbent pads or wet the powder with a suitable solvent and then wipe with a dry cloth. For liquid suspensions, use appropriate sorbents to absorb spill.
* Collect residue, place in container and contact EHS-HMM (734) 763-4568 for proper disposal.
* Include information describing the nanoparticulate nature of the materials on the waste label (e.g., contains nanosilver material).

Because most spent, unused, and expired chemicals/materials are considered hazardous wastes, they must be properly disposed of. **Do not dispose of chemical wastes by dumping them down a sink, flushing in a toilet or discarding in regular trash containers, unless authorized by EHS Hazardous Materials Management (EHS-HMM)**. Contact EHS-HMM at (734) 763-4568 for waste containers, labels, manifests, waste collection and for any questions regarding proper waste disposal. Also, refer to the EHS [Hazardous Waste](http://ehs.umich.edu/haz-waste/) Web page for more information.

# Training of Personnel

All personnel shall read and fully adhere to this SOP when handling engineered nanomaterials.

Training on lab-specific procedures is required for all personnel working with engineered nanomaterials, and must be documented (topics covered, date, employee names and signatures). Laboratory-specific training for work with nanomaterials must include information on the relatively greater hazards of working with nanomaterials, and on the uncertainty of health effects.

# Certification

I have read and understand the above SOP. I agree to contact my Lab Director if I plan to modify this procedure.

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### Major Revisions (Tracking purposes only -- Do not print as part of SOP)

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| Date | Revision |
| 9-19-18 | Updated EHS name and logo and format and revised the Exposure/unintended contact section (AKJ) |
| 02-25-19 | Updated links (DML) |
| 05-12-22 | Removed emergency response procedures section (LGS) |