Nanoparticles

Standard Operating Procedure (SOP)

Type of SOP: ☐ Process/Equipment ☒ Hazardous Chemical

All personnel who are subject to these SOP requirements must review a completed SOP and sign the associated training record. The most current version of the SOPs is located in electronic form on the University's Share Drive. Follow the link below.

S:\University Info\General Information\Emergency Information\Standard Operating Procedures

In addition to the electronic copies, hard copies of the SOPs can be found inside the laboratory, if the SOP pertains to something within a laboratory.

Date SOP Written: 7/22/22	**Approval Date:** 1-11-2024
SOP Prepared By: Michi Dubes	
SOP Reviewed and Approved by CHO (signature): Rose Rakers	
☒ **Department: Biology**	☐ **Campus Wide** ☒ **Lisle** ☐ **Mesa**
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Principal Investigator (PI): Niina Ronkainen	**Phone:** 630-829-6549
Chemical Hygiene Officer (CHO): Dr. Rose Rakers	**Phone:** 630-829-6571
Emergency Contact: Campus Safety Dispatch	**Phone:** 630-829-6122
Location(s) covered by SOP: Building and Room #(s): Birck 106, 108, 150	

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1. **HAZARD OVERVIEW** (What are the hazards?) (i.e., hazards associated are chemicals, fire/explosion, electrical, ergonomic)

REQUIRED – Add a brief description of the process involving hazardous chemicals or equipment covered by this SOP.

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; nanoplates; nanowires; and crystalline structures such as fullerenes and quantum dots. The physical state of nanoparticles can be powder, suspension in a gas or liquid, or solid matrix.

The safety issues with nanoparticles are not very well known but their potential for danger is evident due to the high surface area to volume ratio, which can make the particles very reactive or catalytic. In addition, nanoparticles are able to pass through cell membranes in organisms and may interact with biological systems.

2. HAZARDOUS CHEMICAL(S)

REQUIRED – If the SOP is for a process involving a hazardous chemical(s), provide a list of those chemicals and important properties and signs/symptoms of exposure. List any expected by-products produced if this SOP covers a laboratory process.

Studies on nanomaterials has identified some potential safety hazards and health effects. Because this is such a rapidly emerging field of study, more information will likely become available. The primary routes of exposure for nanoparticles are inhalation, dermal absorption, and ingestion.

3. WHAT ACTIVITIES COULD POSE A RISK?

Activities that could pose a health hazard include:

REQUIRED – Bullet any health hazards associated with the process this SOP is detailing.

Nanoparticles used in laboratory experiments will likely be in one of three forms: a powder, in suspension, or in a sold matrix. Depending on the form of nanoparticle will play a large role in the exposure potential.

A nanoparticle in powdered form presents a larger inhalation hazardous. 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.

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 a 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.

Certain nanoparticles may penetrate cell membranes and may cause damage to intracellular structures and cellular functions.

Activities that could pose a physical hazard include:

REQUIRED – Bullet any physical hazards associated with the process this SOP is detailing.

Some nanomaterials may act as chemical catalysts and produce unanticipated reactions, while some types of nanoparticle dusts may be combustible and require less energy to ignite than larger dust particles, such as sugar or wood, creating a risk of explosion and fire.

4. HOW CAN EXPOSURES BE MINIMIZED?

Elimination/Substitution – **REQUIRED** – If there is another chemical or piece of equipment that can be used which is a safer option but that would have a negative effect on the experiment detail why this is not an option.

There are no alternatives as this is new technology.

Engineering Controls – **REQUIRED** – Insert descriptions of lab-specific engineering or ventilation controls used to reduce chemical exposures (i.e., fume hoods, glove boxes, biosafety cabinets, etc.) or specific equipment safety features. Refer to Section 7 and/or 8 of SDS for proper use.

Fume Hood – Activities that are likely to release nanoparticles (such as opening and emptying of reactors, borosilicate tubes, weighing of dry nanoparticles) 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 vented filtered enclosure. Where operations cannot be enclosed, provide local exhaust ventilation equipped with HEPA filters and designed to capture the contaminant at the point of generation or release.

Furnace Exhaust – Exhaust from all furnaces used to produce nanoparticles must be trapped and connected to a local exhaust source.

Vacuum Protection – Mechanical vacuum pumps must be protected using cold traps and, where appropriate, must include a filter to prevent particulate release. The pump exhaust must be vented into an approved exhaust duct or chemical fume hood.

Glove Box – Certain nanoparticles must be handled in a glove box rather than a fume hood. The PI will determine if this is required.

Decontamination – If heavy usage of aerosolized nanoparticles is in use, a proper decontamination, or buffer, area should be utilized to ensure the nanomaterials are not transported outside of the working area. Frequent hand washing, especially before eating, smoking, applying cosmetics, or leaving the work area should be employed.

Emergency Eyewash – Laboratories and other spaces where nanomaterials are used or stored should be equipped with an eyewash station.

Administrative Controls

The following elements are required:

1. Complete the Hazard Communication and/or Laboratory Safety training prior to working in the laboratory;
2. Complete laboratory-specific safety orientation and training on laboratory-specific safety equipment, procedures, and techniques to be used, including a review of the Chemical Hygiene Plan, prior to receiving unescorted access to the laboratory;
3. Sign off that you read and understand the Chemical Hygiene Plan and what is expected while working in the laboratory;
4. Be familiar with the location and content of any applicable Safety Data Sheets (SDSs) for the chemicals to be used;
5. Implement good laboratory practices, including good workspace hygiene;
6. Inspect all equipment and experimental set-ups prior to use;
7. Follow best practices for the movement, handling, and storage of hazardous chemicals. An appropriate spill clean-up kit should be located in the laboratory. Chemical and hazardous waste storage must follow an appropriate segregation scheme and include appropriate labeling. Hazardous chemical waste must be properly labelled, stored in closed containers, in secondary containment, and in a designated location;
8. Do not deviate from the instructions described in this SOP without prior discussion and approval from the PI and CHO; and
9. Notify the PI, CHO and Emergency Preparedness Manager of any accidents, incidents, near-misses, or upset conditions (i.e., unexpected rise or drop in temperature, color or phase change, evolution of gas) involving the process or hazardous chemical(s) described in this SOP.

REQUIRED – Add any additional administrative controls specifically related to the process, procedure, and restrictions, including controls that may be chemical-specific.

- 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.
- 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.

Personal Protective Equipment (PPE)

At a minimum, long pants (covered legs) and closed toe/closed heel shoes (covered feet) are required to enter a laboratory or technical area where hazardous chemicals are used or stored. In addition to the minimum attire required upon entering a laboratory, the following PPE is required for all work with hazardous chemicals:

A. Eye Protection
    a. Eye protection must be ANSI Z87.1 compliant.
    b. At a minimum, safety glasses are necessary.
    c. Splash goggles must be substituted for safety glasses in chemistry laboratories, and are required for processes where splashes are foreseeable or when generating aerosols.
B. Body Protection: At a minimum, a chemically-compatible laboratory coat that fully extends to the wrist is necessary.
    a. If a risk of fire exists, a flame-resistant laboratory coat that is NFPA 2112 compliant should be worn.
    b. For chemicals that are corrosive and/or toxic by skin contact/absorption additional protective clothing (i.e., face shield, chemically-resistant apron, disposable sleeves, etc.) are required where splashes or skin contact is foreseeable as per the SDS.
C. Hand Protection: Hand protection is needed for the activities described in this SOP. Define the type of glove to be used based on the following:
    a. Chemical(s) being used;
    b. Anticipated chemical contact;
    c. Manufacturer' permeation/compatibility data; and
    d. Whether a combination of different gloves is needed for any specific procedural step or task.

REQUIRED – Add any descriptions of PPE and hygiene practices used with each process or hazardous chemical(s), including any specialized PPE needed for a procedural step/task.

In addition, laboratory coats must be of sufficient length to prevent skin exposure while wearing gloves. Wear commercially available arm sleeves in situation where dermal contact with nanoparticles in powders or in suspensions is expected. Personnel must also wear full length pants, or equivalent, and closed-toed shoes. 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, the following respiratory protection must be worn:

- Filtering face piece (N-95 or greater);
- Elastomeric half- or full-face piece with N-100, R-100 or P-100 filters; or

- Powered air-purifying respirator with N-100, R-100, or P-100 filters.

Anyone required to utilize respiratory protection for use with nanoparticle research must contact the Emergency Preparedness Manager at 630-829-6364 to receive a respiratory fit test prior to working with the nanomaterial.

5. ADDITIONAL GUIDANCE

Spill and Emergency Procedures

Follow the guidance for chemical spill clean-up from the SDS, unless specialized clean-up procedures are described in detail below.

INSERT – Descriptions of any specialized spill clean-up procedures for the hazardous chemicals used in this SOP. Additional details of lab-specific spill clean-up should be provided.

All spills involving nanoparticles should be treated like a hazardous material spill and cleaned up immediately. Immediately evacuate the area and ensure others are aware of the spill. Anyone attempting to manage the spill must be wearing the appropriate PPE. OSHA advises standard approaches to cleaning nanomaterial powder and liquid spills include the use of HEPA-filtered vacuum cleaners, wetting powders down, using dampened cloths to wipe up powders, and applying absorbent materials or liquid traps. Energetic cleaning methods such as dry sweeping or the use of compressed air should be avoided or only be used with precaution that assure that particles suspended by the cleaning action are trapped by HEPA filters. If vacuum cleaning is employed, care should be taken that HEPA filters are installed properly, and bags and filters changed according to manufacturer's recommendations. At a minimum, the following procedures must be followed when managing an accidental spill of nanomaterials:

- Clean-up should only be handled by trained individuals. Contact the Chemical Hygiene Officer and/or Emergency Preparedness Manager to determine if outside assistance is warranted.
- Small spills (less than 5 mg) of nanomaterials containing powder should be wet-wiped with cloth/gauze that is dampened with soapy water. After surfaces should be thoroughly wet-wiped three times over with appropriate cleaning agent and with a clean, damp cloth used for each wipe down. Following completion, all cloth and other spill clean-up materials with a potential for nanomaterial contamination must be disposed of as hazardous waste.
- Small spills (less than 5 ml) of nanomaterial-containing solutions should be covered and absorbed with absorbent material. Areas affected by liquid spills should be triple cleaned with soap and water following removal of absorbent paper.
- For larger spills, contact the Chemical Hygiene Officer and/or Emergency Preparedness Manager.

As with any spill or clean-up of contaminated surfaces, handling and disposal of the waste material should follow existing Federal, State, or local regulations.

Disposal and Decontamination Procedures

Hazardous waste must be properly labeled and removed from your laboratory within six (6) months of the accumulation start date. Hazardous waste should be brought down to the Chemical Stockroom. Speak with the CHO prior to bringing the waste.

REQUIRED – Add descriptions of laboratory-specific information on the waste streams generated, storage location, and any special handling/storage requirements.

Since the toxicology and environmental fate of nanoparticles is still largely unknown, all nanoparticle waste (solid 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".

REQUIRED – Add descriptions of decontamination procedures for equipment, glassware, and controlled areas (i.e., glove boxes, fume hood).

Use good housekeeping practices to avoid contamination of surfaces. Clean bench tops using a cleaning solution after each work activity.

Upon completion of work with hazardous chemicals and/or decontamination of equipment, remove gloves and/or PPE to wash hands and arms with soap and water. Additionally, upon leaving a designed hazardous chemical work area remove all PPE worn and wash hands, forearms, face and neck as needed. Contaminated clothing or PPE should not be worn outside the lab. Grossly contaminated clothing/PPE and disposable glove must not be reused.

Shipping and Transportation

Follow the Shipping Hazardous Materials policy found at **S:\University Info\General Information\Emergency Information**.

Fires

INSERT – Add descriptions of what to do in case of a fire as described by the process mentioned in this SOP.

Some types of nanoparticle dust may be combustible creating a risk of explosions and fire.

Exposure Requiring the Use of Emergency Shower and/or Eyewash/Drench Hose

- Have someone call 911 (report the building name, street address (located near the door to the room on the Emergency Procedures sheet) and room number.
- Contact Campus Safety at 630-829-6122 to report the incident and let them know you called 911.
- Have someone obtain the SDS for the material and provide it to the first responders upon arrival.
- Assist the affected individual to position their head over the eyewash/drench hose located in the laboratory and activate it if the eyes or face are affected. If the exposure is on the body assist the affected individual to the emergency shower in the hallway and activate it. The activation of either the eyewash or shower located in the hallway will trigger an alarm notifying Campus Safety. Ensure your own safety before helping others. Only help if it is safe for you to do so.
- Instruct the affected individual to open their eyes and roll them around while the water is flowing or to stand under the shower with the affected area being covered in water.
- Flush the affected area for 15 minutes with water.

- Notify the Emergency Preparedness Manager as soon as possible and complete the Accident/Incident Form.

6. TRAINING

To teach and learn inside a laboratory, certain training must take place. All individuals must take a Laboratory Safety online course. If your laboratory involves chemicals for chemistry or biology, individuals must also take the Hazard Communication online course. These two online courses are set up with the Emergency Preparedness Manager.

Refresher training for the Hazard Communication course will be taken if the individual completed the full three-part course within six (6) months. If it has been close to or over one (1) year, the full three-part course will need to be repeated. The Laboratory Safety course will be repeated if the individual completed the course over one (1) year prior.

In addition to the online courses, students are required to complete laboratory-specific training to be able to stay in the laboratory.

No researcher may work independently with the hazardous material described in this SOP until the PI or their designee has ensured that the researcher:

- Has completed all required laboratory safety training;
- Understands the hazards of the materials and risks of the processes involved;
- Had read and understands the contents of this SOP; and
- Demonstrates the ability to execute their work according to the requirements in this SOP.

7. SOURCES AND ADDITIONAL RESOURCES

List all sources and additional resources that contributed to the creation of this SOP.

Mandal, Dr. Ananya, 2019, Safety of Nanoparticles, https://www.news-medical.net/life-sciences/Safety-of-Nanoparticles.aspx

Occupational Safety and Health Administration (OSHA) Fact Sheet, 2013 https://www.osha.gov/sites/default/files/publications/OSHA_FS-3634.pdf

Purdue University, 2015, Nanoparticles Standard Operating Procedure

The University of Texas, Nanoparticles Safety Guide, https://www.uth.edu/dotAsset/c6d9a7b4-bdc9-424b-b849-bd6cbadcc398.pdf

University of Pennsylvania, 2022, SOP: Nanoparticles, Safe Handling https://ehrs.upenn.edu/health-safety/lab-safety/chemical-hygiene-plan/standard-operating-procedures/sop-nanoparticles-safe

All personnel shall read and fully adhere to and acknowledge the contents, requirements, and responsibilities outlined in this SOP.

☐ I have read and acknowledge the contents, requirements, and responsibilities outlined in this SOP.

Print Name:	Signature:
BenU ID:	Date: