**NANOMATERIALS**

**STANDARD OPERATING PROCEDURE TEMPLATE**

**Type of SOP:**  ProcessHazardous Chemical Hazard Class

To customize this SOP, add lab-specific information to the sections below marked in RED, as applicable. Completion of the last section (“Lab-Specific Information”) is required. Also, any of the content below may be amended with lab-specific information to enhance worker safety as desired.

For more information, consult the Safety Data Sheet for a particular nanomaterial – if available.

1. **HAZARD OVERVIEW**

Engineered nanomaterial/particles are particles that have at least one dimension between 1-100 nanometers. Particles in this size range have always been present in Earth’s air. Nanoparticles may be naturally occurring (such as in volcanic ash), produced as unintentional byproducts (such as in auto emissions) or intentionally created or “engineered.” These very small particles often possess radically different properties than larger particles of the same composition.

Nanoparticles can be spheres, rods, tubes, and other geometric shapes. The small particles may be bound to surfaces or substrates, put into solution or suspension, attached to a polymer, or in a few cases handled as a dry powder. Various nanoparticles can be created in the laboratory and some can be purchased from commercial vendors.

Only limited information is currently available on the toxicity of a few types of nanoparticles. **It is believed that** **some engineered nanoparticles may present health effects following exposure, based in part on air pollution studies that show smaller particles get deep into the lungs and can cause human illness.** However, laboratory research most commonly involves handling nanoparticles in liquid solutions or other forms that do not become easily airborne, and even free-formed nanoparticles tend to agglomerate to a larger size.

When research involves work with engineered nanoparticles for which no toxicity data is yet available, it is prudent to assume the nanoparticles may be toxic, and to handle the nanoparticles using the laboratory safety techniques outlined below.

**Potential Routes of Occupational Exposure to Researchers**

*Inhalation:* Respiratory absorption of airborne nanoparticles may occur through the mucosal lining of the trachea or bronchioles, or the alveolus of the lungs. Because of their tiny size, certain nanoparticles appear to penetrate deep into the lungs and may translocate to other organs following pathways not demonstrated in studies with larger particles. Thus, whenever possible, nanoparticles are to be handled in a form that is not easily made airborne, such as in solution or on a substrate.

*Skin Absorption:*  In some cases nanoparticles have been shown to migrate through skin and be circulated in the body. If the particle is carcinogenic or allergenic, even tiny quantities may be biologically significant. Skin contact can occur during the handling of liquid suspensions of nanoparticles or dry powders. Skin absorption is much less likely for solid bound or matrixed nanomaterials.

*Ingestion:* As with any material, ingestion can occur if good hygiene practices are not followed. Once ingested, some types of nanoparticles might be absorbed and transported within the body by the circulatory system.

*Injection:*  Exposure by accidental injection (skin puncture) is also a potential route of exposure, especially when working with animals or needles.

1. **PERSONAL PROTECTIVE EQUIPMENT (PPE)**

*General:* See the PPE information under Sec. II of the *UCSB Chemical Hygiene Plan* regarding:

* the UC PPE Policy and policy summary (what a PPE is needed and when/where to use)
* obtaining your PPE via use of the *Laboratory Hazard Assessment Tool*
* glove selection criteria
* respirator use, etc.

*Specific:* see part 4. below.

1. **ENGINEERING/VENTILATION CONTROLS**

Nanomaterials should always be used in a properly functioning fume hood, particularly if the material is in its free state and not in solution, or bound to a matrix. Alternatively, a special ventilated work bench with high-efficiency particulate filters (“HEPA”) can be used for nanomaterials. These are specially designed for use of these materials.

*General:* For further information on engineering controls, see these pages in Sec. II of the *UCSB Chemical Hygiene Plan:*

* Fume Hood Usage Guide
* Criteria for Implementing Engineering Controls

*Specific:* see part 4 below.

1. **SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS**

The current practices for working with engineered nanoparticles safely are essentially the same as one would use when working with any research chemical of unknown toxicity.

1. Wear double gloves (preferably nitrile gloves), safety glasses or goggles, and appropriate protective clothing. The gloves will help prevent skin exposure and reduce the chances of accidental injection by needle, or animal bite. Outer gloves should always be removed inside the hood or under the influence of local exhaust ventilation and placed into a sealed bag. This will prevent the particles from becoming airborne. Place a *Tacki-Mat* at the exit to reduce the likelihood of spreading nanoparticles.
2. All personnel participating in research involving nanoscale materials need to be briefed on the potential hazards of the research activity, as well as on proper techniques for handling nanoparticles. The contents of this SOP can serve as a useful component of this training. As with all safety training, written records need to be maintained to indicate who has been trained on this topic.
3. To prevent ingestion, eating and drinking and chewing gum are not allowed in laboratories, except perhaps in designated areas.
4. When purchasing commercially available nanoscale materials, be sure to obtain the Safety Data Sheet (MSDS) and to review the information in the SDS with all persons who will be working with the material. Note, however, that given the lack of extensive data on nanoparticles, the information on an SDS may be more descriptive of the properties of the bulk material.
5. In some cases, the manufacture of nanomaterials involves the use of chemicals that are known to be hazardous. Be sure to consider the hazards of the precursor materials when evaluating the process hazard or final product. Users of any chemicals should make themselves familiar with the known chemical hazards by reading the SDS or other hazard literature.
6. To minimize airborne release of engineered nanoparticles to the environment, nanoparticles are to be handled in solutions, or attached to substrates so that dry material is not released. Where this is not possible, nanoscale materials should be handled with engineering controls such as a HEPA-filtered local capture hood or glove box. If neither is available, work should be performed inside a laboratory fume hood. HEPA-filtered local capture systems should be located as close to the possible source of nanoparticles as possible, and the installation must be properly engineered to maintain adequate ventilation capture.
7. Use fume exhaust hoods to expel any nanoparticles from tube furnaces or chemical reaction vessels. Do not exhaust aerosols containing engineered nanoparticles inside buildings.
8. If you must work outside of a ventilated area with nanomaterials that could become airborne, wear a respirator with NIOSH-approved filters that are rated as N-, R- or P-100 (HEPA). EH&S will work with researchers to provide the most appropriate type of respirator.
9. **SPILL AND INCIDENT PROCEDURES**

See general directions under the “Chemical Incident” and “Medical Emergency” tabs of the *UCSB Emergency Information Flipchart* – should already be posted in all labs.

Spills of engineered nanoparticles are to be cleaned up right away.

* The person cleaning up should wear double nitrile gloves and either vacuum up the area with a HEPA-filtered vacuum or wet wipe the area with towels, or combination of the two.
* For spills that might result in airborne nanoparticles, proper respiratory protection should be worn (see above). For assistance with cleaning up any chemical spill contact EH&S.
* Do not brush or sweep spilled/dried nanoparticles.
* Place *Tacki-Mat* at the exit to reduce the likelihood of spreading nanoparticles.

1. **DECONTAMINATION**

Work surfaces should be wet-wiped regularly – daily is recommended. Because many engineered nanoparticles are not visible to the naked eye, surface contamination may not be obvious. Alternatively, disposable bench paper can be used.

Lab equipment and exhaust systems used with nanoscale materials should be wet wiped and HEPA vacuumed prior to repair, disposal, or reuse. Construction/maintenance crews should contact EH&S for assistance.

1. **WASTE DISPOSAL**

See “Chemical Waste Disposal” in Sec. II of the *UCSB Chemical Hygiene Plan*.

All waste nanoparticles should be treated as unwanted hazardous “toxic” materials unless they are known to be non-hazardous. Dispose of and transport waste nanoparticles in solution according to hazardous waste procedures for the solvent.

1. **PRIOR APPROVAL/REVIEW REQUIRED**

As they deem necessary, the PI/supervisor should insert here any prior approval or review needed, before an individual can do the operation.

1. **DESIGNATED AREA**

As they deem necessary, the PI/supervisor should insert here any information about whether a special use-area is designated for this material/process.

1. **SAFETY DATA SHEETS and OTHER REFERENCES**

-Safety Data Sheets (MSDS):Found online at: <http://ehs.ucsb.edu/labsafety/msds>

-A short video from Dow Chemical on lab handling of nanomaterials is found at:

[**http://www.ehs.ucsb.edu/labsafety/chemical-safety**](http://www.ehs.ucsb.edu/labsafety/chemical-safety)

1. **LAB-SPECIFIC INFORMATION (required) *(***[*Examples*](http://www.ehs.ucsb.edu/labsafety-chp/sec1/three-examples-language-used-customize-standard-operating-procedure)***of appropriate content)***

Add appropriate lab-specific information here describing how this material(s) is generally used. E.g., name of protocol, typical frequency done, quantities used, temperature and any additional safety measures, etc.