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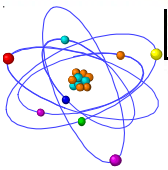
LABORATORY SAFETY FACT SHEET #36



Engineered Nanomaterials: Guidelines for Safe Research Practices

Introduction

This document provides environmental, health and safety information to researchers working with engineered nanoparticles, and should be formally incorporated as a Standard Operating Procedure into each laboratory's Chemical Hygiene Plan binder (Cal-OSHA requirement). Researchers are encouraged to customize this document as appropriate to their operation. Given the evolving knowledge base regarding health effects of nanoparticles, this fact sheet may be updated.

Nanoparticles 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, making them of interest to researchers and of potential benefit to society. This fact sheet focuses on lab practices researchers should follow to protect themselves from the hazards of engineered nanoparticles.

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 under experimental procedures, and some can be purchased from commercial vendors. In most research, the amount of material used is small, generally less than a gram.

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

There are four possible routes of workplace exposure to nanoparticles: inhalation, ingestion, skin absorption, and injection.

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.

Laboratory Safety Guidelines for Handling Engineered Nanoparticles

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 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 Fact Sheet 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 Material Safety Data Sheet (MSDS) and to review the information in the MSDS 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 MSDS 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 MSDS 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. An example of a HEPA-filtered hood specifically for nanomaterials is shown. 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.

Example of HEPA-filtered hood at UCSB specifically for nanomaterial use

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. 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.

10. Spills of engineered nanoparticles are to be cleaned up right away.
    a. 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.
    b. For spills that might result in airborne nanoparticles, proper respiratory protection should be worn (see item 8 above). For assistance with cleaning up any chemical spill contact EH&S.
    c. Do not brush or sweep spilled/dried nanoparticles.
    d. Place Tacki-Mat at the exit to reduce the likelihood of spreading nanoparticles.

11. 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.

12. 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. If you have questions on how to dispose a specific nanoparticle waste, call EH&S for more information.

For more information on Health and Safety of Nanotechnology visit the following web sites:

National Institute of Occupational Safety and Health
(http://www.cdc.gov/niosh/topics/nanotech/)

National Nanotechnology Initiative (http://www.nano.gov/)

EPA (http://www.epa.gov/oppt/nano/nano-facts.htm)

Woodrow Wilson International Center for Scholars (http://nanotechproject.org/)