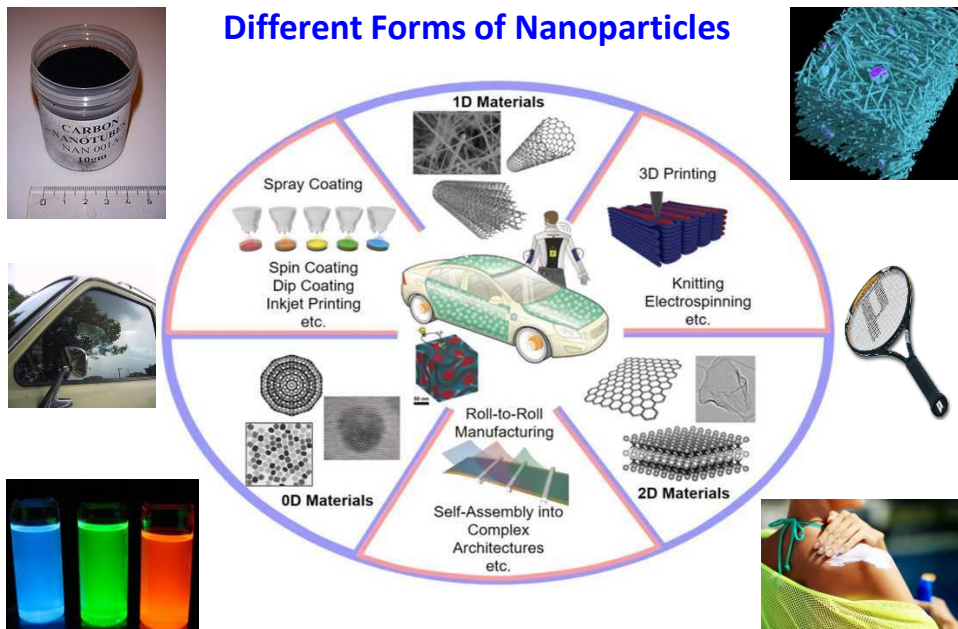


# ME4252 Nanomaterials for Energy Engineering

## Safety Aspects of Nanomaterials

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Nanoparticles or nanomaterials used in laboratory experiments will be likely in one of three forms: a powder, in suspension, or in a solid matrix.

## Safety Issues – Why are we concerned?

- The ultrasmall particle size permits the particles to be carried deeply into tissues
- The molecular structure of nanoparticles and the relatively greater surface area confer on these particles different chemical reactivities than for larger structures made from the same elements or molecules.
- Nanoparticles present a unique challenge from an occupational health perspective as there is a **limited amount of toxicological data** currently available for review. Various agencies are currently studying this issue, and improved guidelines for handling and disposal will be forthcoming. Currently, many agencies provide safety guidelines, promote the incorporation of cautionary measures in research, with a view toward minimizing or eliminating exposures to nanoparticles.


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## Exposure Pathways

- **Inhalation.** Respiratory absorption of airborne nanoparticles may occur through the mucosal lining of the trachea or bronchioles, or the alveolus of the lungs. Certain nanoparticles appear to penetrate deep into the lungs and may translocate to other organs or pass through the blood-brain barrier. 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.
- **Dermal 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.

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## How to Handle Nanomaterials Safely?




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Control Measures

Control measures prevent exposure to hazardous substances.

Appropriate control measures must be implemented in the following hierarchy:



The pyramid is divided into five horizontal layers, colored from green at the top to red at the bottom:

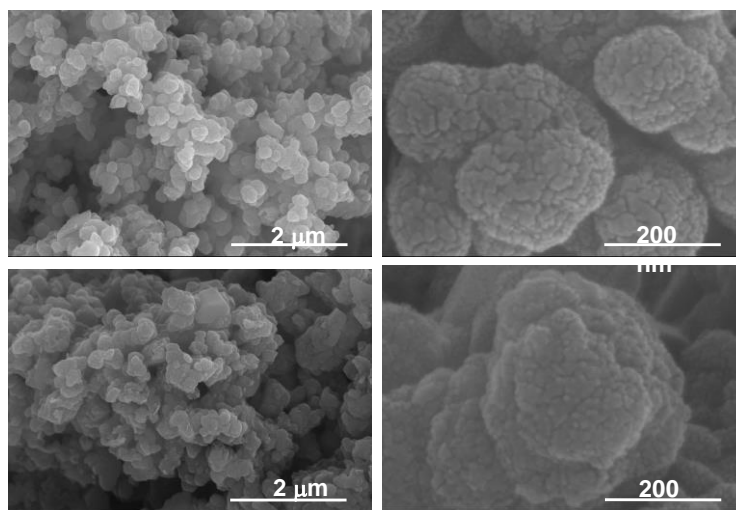
1. Elimination
2. Substitution
3. Engineering Controls
4. Administrative Controls
5. Personal Protective Equipment

To the right of the pyramid, a green arrow points upwards from layer 5 to layer 1, labeled "Most Effective To be considered first". A red arrow points downwards from layer 1 to layer 5, labeled "Least Effective".

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## Mesoporous Materials Instead of Nanoparticles (Substitution)



$\text{Li}_3\text{V}_2(\text{PO}_4)_3$  mesoporous materials

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## Laboratory Safety Guidelines for Handling Engineered Nanoparticles

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

- **Use Fume Hood or Glove Box**

If handling or transporting materials outside of a glovebox, workers should wear protective equipment, including

- **Latex or nitrile gloves** when handling nanoparticle powders and nanoparticles in suspension (glove changes should be performed frequently); 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.
- **Chemical splash goggles** when working with nanomaterials in suspension or dry powdered form;
- **Lab coats** Lab coats should be laundered on a periodic basis. Do not take lab coats home for laundering;

The use of respirators is not generally required for worker protection if you work in a ventilated area.

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## Laboratory Safety Guidelines for Handling Engineered Nanoparticles

- 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.
- **Nanoparticle solutions may be handled on the lab bench once placed in solution.**
- **Transport of nano-materials should employ a sealed secondary containment device.**
- 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. The cleaning solution should be compatible with the vehicle in which the nanoparticles are suspended.
- To prevent ingestion, eating and drinking and chewing gum are not allowed in laboratories
- Report any safety concern

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## 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.**
- **Nanoparticle waste must be placed in an appropriate container and labeled for chemical content in compliance the hazardous waste management requirements.**

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Thank you