Nanotechnology

Information on potential hazards
and risks involved with
nanotechnology and controls
used to limit exposure

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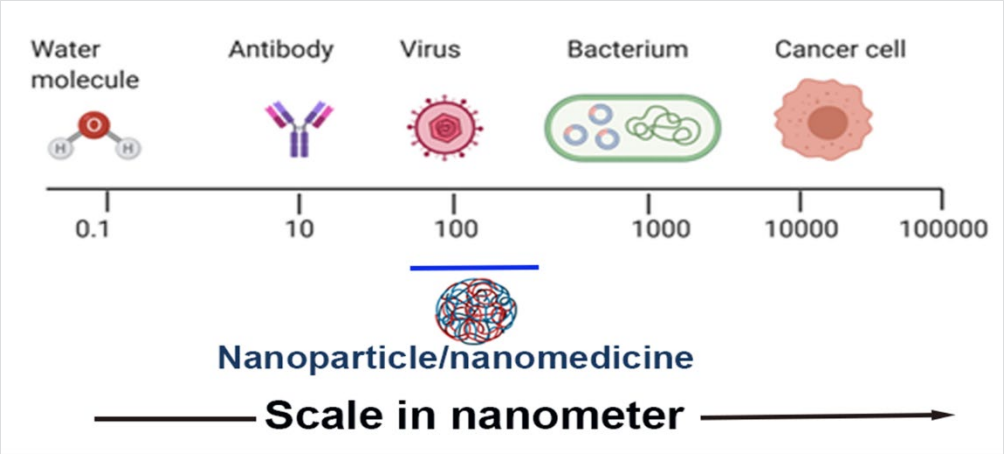
Nanotechnology

- Manipulation of materials at the molecular level
- Between 1-100 nanometers (nm)
- Engineered nanomaterials have unique chemical and physical properties



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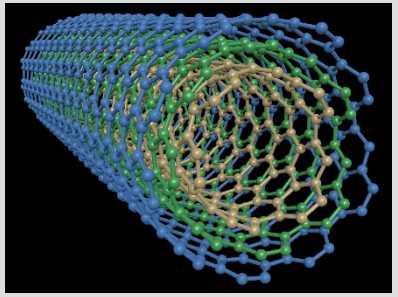
Properties

- High surface area to volume ratio increases reactivity
- Solubility and charge influence biological activity
- Size and shape can mimic biomolecules
- Small size allows them to enter cells and organelles and to readily transport through air and water

Types of Engineered Nanoparticles

- Zero-valent and metal oxide
- Carbon nanotubes
- Quantum dots
- Buckyballs
- Polymer based (dendrimers, liposomes, etc.)



Occupational Hazards of Nanotechnology

- Little information on toxicity or exposure limits
- No Occupational Exposure Limit (OEL) for nanomaterials
- No regulations or guidelines to provide occupational protection

What We Do Know

- Particles are at highest risk for exposure when they are not fixed to a surface
  - Powder
  - Aerosolized liquid
- Known nano/micro particle hazards
  - Asbestos
  - Coal mine dust
  - Silica
- Unknown hazards = treat all nanoparticles as hazardous

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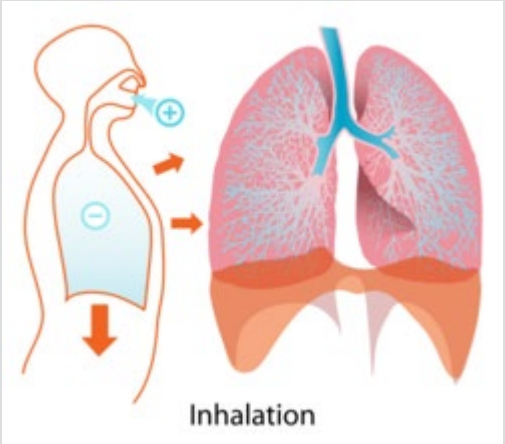
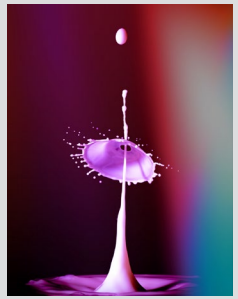
Possible Routes of Exposure

- Inhalation
  - Most common
  - Handle nanoparticles in solution to prevent inhalation of dusts/aerosols
- Ingestion
  - Unintentional contamination of mouth
  - Swallowing particles cleared from respiratory tract
- Dermal
  - Potential to penetrate skin
- Exposure affected by
  - Concentration
  - Duration
  - Frequency



Job Related Exposure Risks

- Handling powdered nanomaterials
- Working with nanoparticles in suspension without proper protection
- Generating nanoparticles in open systems



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Risk Assessment

- Should be based on type of nanomaterial
  - Composition
  - Shape
  - Size
  - Surface area
  - Physical state
- Nanomaterial Risk Level (NRL) Summary Chart is a helpful tool to start with
- Reference SDS

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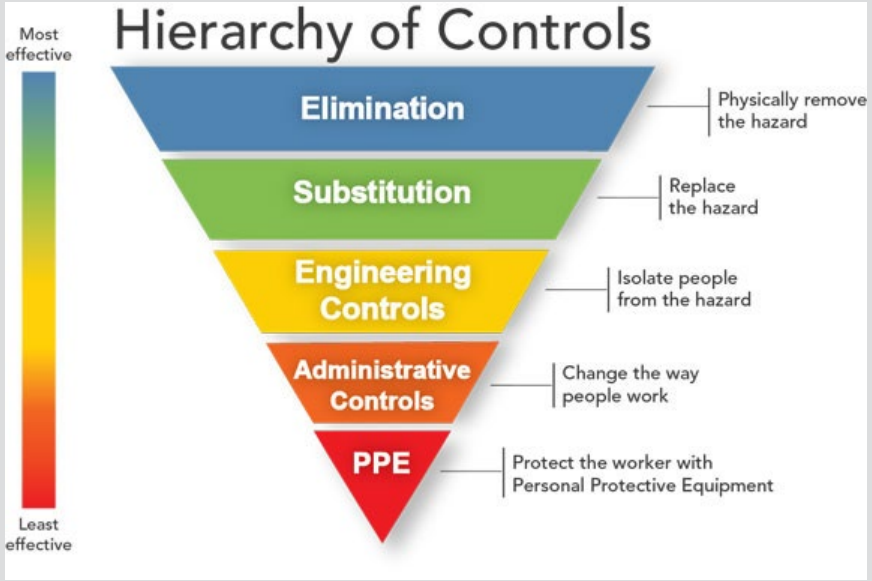
Safety Controls

- Utilize proper engineering controls
- Institute adequate administrative controls
- Utilize PPE when necessary
- Contact EHS for guidance
- Must be include in your Lab Safety Plan



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Nanomaterial Risk Level Summary Tool

NRL	Nanomaterial	Engineering Controls	Administrative Controls	PPE
1	Polymer matrix	Fume hood or Class II A1 or A2 vented via thimble connection or B1 or B2 BSC	Standard lab practices for labeling, secondary containers, waste management, and signage	Lab coat, gloves, safety glasses with side shields
2	Liquid	Fume hood or Class II A1 or A2 vented via thimble connection or B1 or B2 BSC or approved vented balance safety enclosure	NRL1 plus: • Secondary containment for storage • Clean contaminated areas with wet, disposable wipes • All waste including cleaning materials and PPE is considered hazardous	NRL1 plus: • Gloves must be nitrile • Safety goggles
3	Powders or aerosol generating procedures	Fume hood or Class II A1 or A2 vented via thimble connection or B1 or B2 BSC or approved vented balance safety enclosure. HEPA filtered exhaust preferred for fume hoods containing large-scale work with powders	NRL2 plus: • Must have vacuum with HEPA filter for clean-up • Label work area with “Caution Hazardous Nanoscale Materials in Use”	
4	Dry Powders or aerosols of parent materials with known toxicity or hazards	Fume hood or Class II B1 or B2 BSC or glove box or approved vented balance safety enclosure. HEPA filtered exhaust with Bag-In/Bag-Out capability preferred for hoods, BSCs, and gloveboxes.	NRL3 plus: • Baseline medical evaluation including physical exam, pulmonary function test (PFT) and routine blood work. • Access to the facility granted only to persons trained and authorized by EHS for access.	

Safety Data Sheets

- Carbon black, graphite, diamonds, buckyballs, and carbon nanotubes are all pure carbon with different molecular configurations
- SDS for some commercially available carbon nanotubes refer to the permissible exposure limit (PEL) for graphite
  - Graphite is made of coarse particle while nanotubes are made of fibers and behave much differently
  - The SDS is not always accurate because they reference the base chemical and NOT the formulation or grade specific to the nanomaterial

Engineering Controls

- Based on NRL Summary Tool
- HEPA filters recommended
- Fume hood or Class II A or B Biosafety Cabinet is minimum

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Administrative Controls

- SOPs are written and trained for working with nanomaterials
- Proper clean up of nanomaterials is trained and equipment is present and maintained
  - HEPA vacuum and wet methods
- Designated food and drink areas are distinct from areas where nanomaterials are handled
- Areas where nanomaterials are handled are restricted to authorized personnel only

PPE

- Essential for minimizing exposure when handling nanomaterials
- Appendix D of the NCCU Lab Safety Manual is a PPE Selection Guide
- Basic PPE always includes
  - Gloves – must be resistant to any solution which may contain nanoparticles
    - OSHA provides guidance on glove compatibility
  - Eye protection – safety glasses or goggles
  - Lab coat

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Respiratory Protection

- Respirators may be required for certain work operations
  - Must be proper type – does NOT include surgical or medical masks
  - Must be enrolled in NCCU Respiratory Protection Program
    - Be medically cleared
    - Be fit tested
- A P100 is recommended for work with nanomaterials

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Nanoparticle Waste

Waste	Storage	Submit for Pickup
Pure nanomaterials in solid form	Containerized and properly labeled	Hazardous waste
Nanomaterials dissolved in solvents or formulations	Containerized and properly labeled	Mixed Hazardous waste
Contaminated paper, PPE, tissue culture consumables, wipes, tips, pipettes, etc.	Double bag and store in secondary container; must use biohazards bag if appropriate	Hazardous waste

- NCCU handles all nanomaterials waste as hazardous
- Submit Hazardous Waste Pickup Form

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Additional Resources

- CDC/NIOSH Safe Nanotechnology in the Workplace
- OSHA Fact Sheet Working Safely with Nanomaterials
- NIOSH Safety & Health Topic Nanotechnology

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Questions

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EHS Website

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