Nanomaterial Safety in Academic Settings

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UNIVERSITY OF CALIFORNIA

UC CEIN Center for Environmental Implications of Nanotechnology

University of California Los Angeles, Santa Barbara, Davis, Riverside

Columbia University, University of Texas, University of New Mexico, Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory

University College Dublin, Nanyang Techonological University, Cardiff University Wales, University of British Columbia, Universitat Rovira i Virgili, Foundation Institute for Materials Science

What are the barriers?

1. Perception that risk is low or unknown
2. Perception that there is not good guidance available on how to lower risk
3. Perception that actions needed to lower risk would be onerous or costly
4. Reality that activities and materials are extremely diverse in academic settings (even within one lab)

California Nanosafety Consortium of Higher Education

Representatives include:

- *Individuals from Government Agencies*
  - National Institute of Occupational Safety and Health (NIOSH), Department of Toxic Substances Control (DTSC)
- *University Environmental Health and Safety Professionals (EH&S)*
  - University of California, Los Angeles (UCLA), University of California, Irvine (UCI), University of California, Riverside (UCR), University of California (UC) Regents, University of Southern California (USC), Stanford, CalTech, and Claremont University Consortium
- *Professors and Graduate Students*
  - UCLA, University of California, Santa Barbara (UCSB)

Special thanks to: Khadeeja Abdullah, Larry Gibbs, Mary Dougherty

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

National Institute for Occupational Safety and Health NIOSH

UC Center for Laboratory Safety

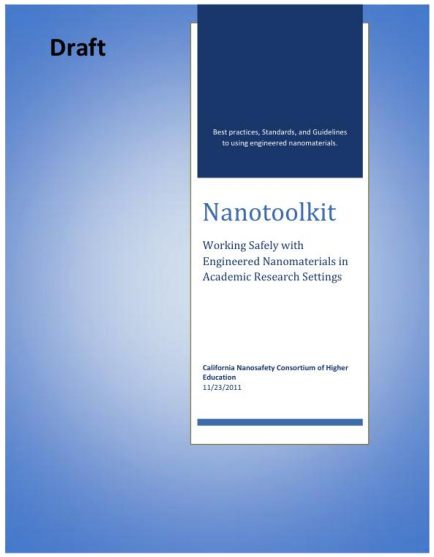
Methodology

- Compiled recommendations from > 40 guidance documents into a matrix
- Reviewed exposure literature to ascertain whether specific recommendations are based on science
- Analyzed recommendations:
  - EH&S personnel rated recommendations based on professional judgement and whether there was a need for more research based on literature and professional knowledge.
- Developed Toolkit based on "best" recommendations

Deliverable: Nano Toolkit

Easy to use Nano Toolkit academic researchers that:

- Gives basic NM information including latest on hazards;
- Help researchers easily identify whether the work they propose to perform is in a low, medium, or high risk category based on potential for exposure;
- Provides recommend steps (exposure controls, work practices, and PPE) to minimize exposure at the various risk levels.



Helping Researchers Understand Risk

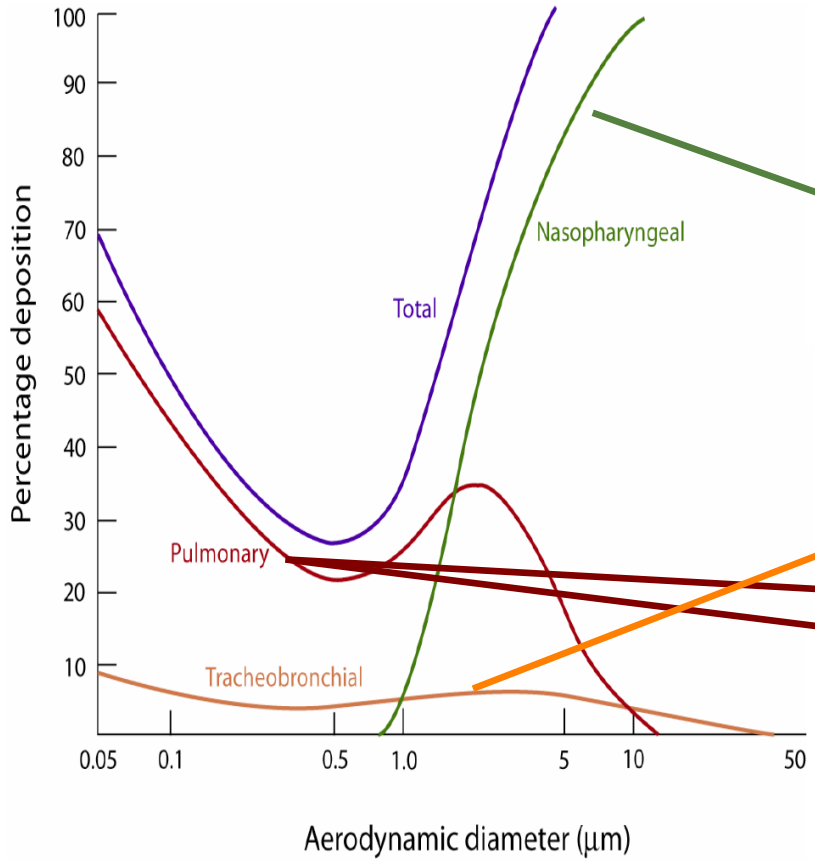
Technical Definition of Risk:

Risk = (Hazard) X (Probability of Exposure)

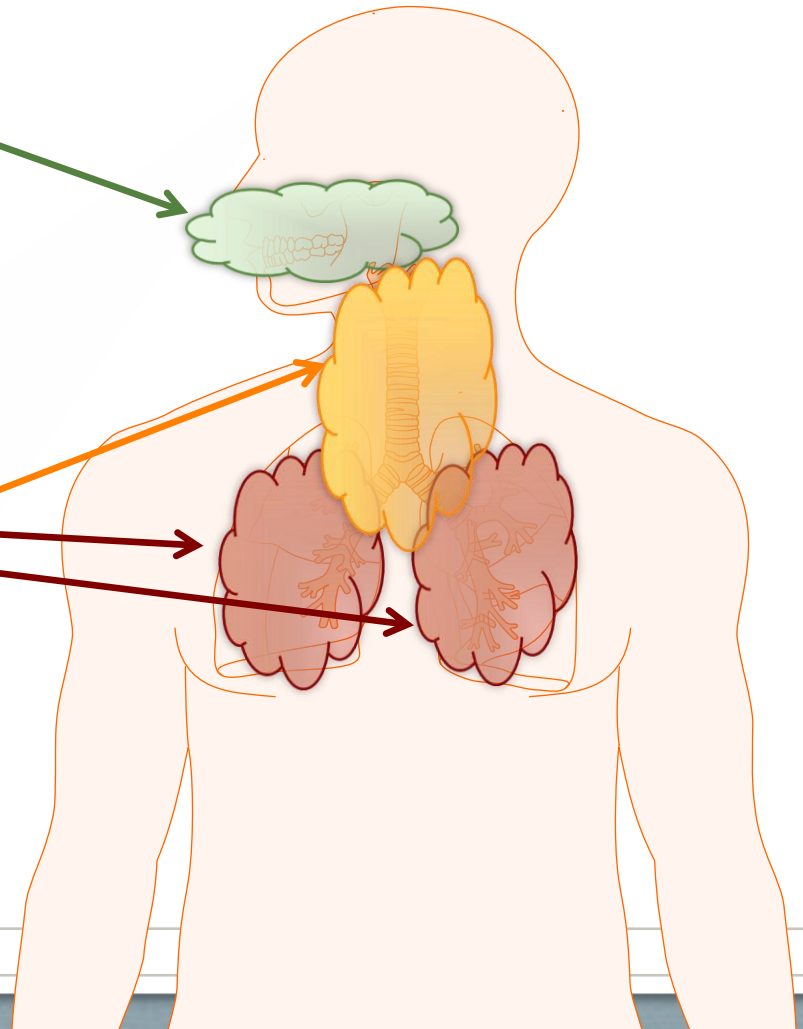
Implications:

- If there is no exposure, there is no risk
- If there is no hazard, there is no risk

Nanometer-sized particle deposit in the smaller branches of lung and the air exchange area



Adapted from Annals of American Conference of Governmental Hygienists, Vol. 11



What happens when ENMs reach the smaller branches of the lungs?

http://www.cdc.gov/niosh/docket/review/docket161A/pdfs/carbonNanotubeCIB_PublicReviewOfDraft.pdf

In the case of Carbon Nanotubes (CNTs):

- Generation of reactive oxygen species (ROS)
- Early onset and persistent fibrosis
- Aberrant cell division

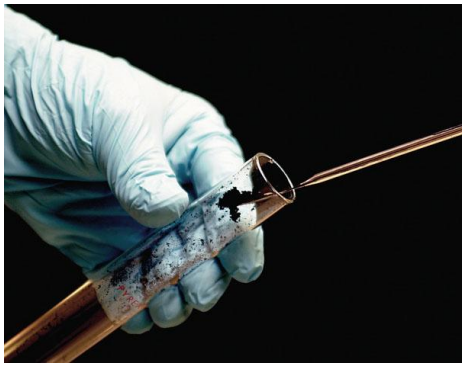
NIOSH has established Recommended Exposure Limits for CNTs

REL (recommended exposure limit) for CNTs is 7.0 μg/m^3

(REL for carbon black= 3.5 mg/m^3 and 0.1 mg/m^3 for carbon black in the presence of PAH's; OSHA PEL for graphite = 15 mg/m^3

http://www.cdc.gov/niosh/docket/review/docket161A/pdfs/carbonNanotubeCIB_PublicReviewOfDraft.pdf

http://www.flickr.com/photos/niosh/5589170045/



http://2020science.org/2008/12/01/indecent-exposure/

But how do we know what the potential for exposure is and hazards are for other NMs?

Hazard/Toxicity Score

- How do physicochemical properties correlate with toxicity/hazard?
- How can we make materials that are “safer by design”?

Exposure Score

- What activities are likely to lead to exposure and why?
- What can we can do to minimize the risk of exposure?

RISK

Nanotoolkit: how to minimize your risk when elimination or substitution are not options

- Elimination
- Substitution
- Engineering Controls
- Work Practices
- Use of Personal Protective Equipment

REDUCE (OR ELIMINATE) EXPOSURE

Primary Criteria for Assessing Risk: Exposure Potential

	Category 1 Low Exposure Potential
Material State and Conditions of Use	• ENMs bound in a substrate or matrix • ENMs in water-based liquid suspensions or gels • Use causes no potential for release of ENM into air • No thermal or mechanical stresses
NM Handling Examples	• Non-destructive handling of solid engineered nanoparticle composites or nanoparticles permanently bonded to a substrate

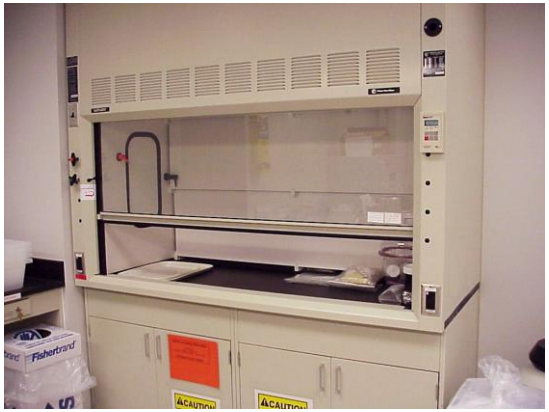
Recommendations for Low Risk NM Activities

Engineering Controls: same as regular good practices;; fume hood if practical

Personal Protective Equipment: same as regular good practices

Work Practices: same as regular good practices *AND*

- *Line work space with absorbant material*
- *clean spills immediately using wet wiping or HEPA-filtered vacuum*
- *Label as containing ENMs*



Moderate Potential for Exposure

	Category 2 Moderate Exposure Potential
Material State and Conditions of Use	• ENMs as powders or pellets • ENMs in solvent-based liquid suspensions or gels • Use causes potential release of ENMs into air • Thermal or mechanical stresses induced
NM Handling Examples	• Pouring, heating, or mixing liquid suspensions (e.g. stirring or pipetting), or operations with high degree of agitation involved (e.g., sonication) • Weighing or transferring powders or pellets • Bedding change out of laboratory animal cages

Recommendations for Medium Risk NM Activities

Engineering Controls: same as low but

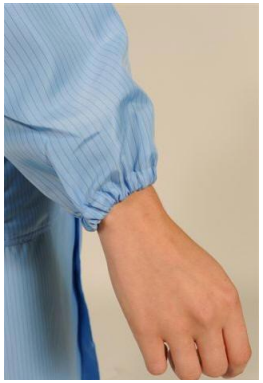
- *working in enclosure highly recommended*

Personal Protective Equipment: same as low *AND*

- *double gloves recommended*
- *N95 respirator if not working in enclosure*
- *labcoat with elastic wrists (disposable preferred) and booties recommended*

Work Practices: same as low *AND*

- *post signs; use sticky mats*



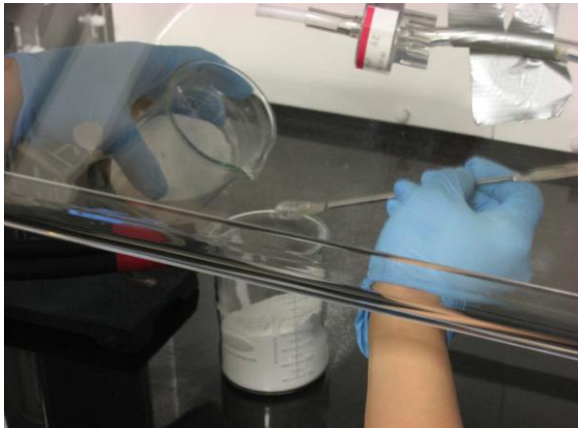


image courtesy of Center for High-Rate NanoManufacturing, UMass Lowell and Pharmaceutical Containment Technologies

High Potential for Exposure

	Category 3 High Exposure Potential
Material State and Conditions of Use	• ENMs suspended in a gas • ENMs as powders or pellets with extreme potential for release into air
NM Handling Examples	• Generating or manipulating ENMs in the gas phase or in aerosol form. • Furnace operations • Cleaning reactor • Cleaning of dust collection systems used to capture ENMs • High speed abrading/grinding nanocomposite materials

Recommendations for High Risk NM Activities

Engineering Controls: same as medium but

-working in enclosed system essential

Personal Protective Equipment: same as medium but

-N95 respirator essential if not working in enclosed system

Work Practices: same as medium

Other Items in ToolKit

- Summary of Guidelines for Choice of Gloves When Working with ENMs
- Spill Response Guidelines/SOP
- Disposal Guidelines by Waste Stream Type

Future Activities

- Collaborate with NIOSH site visit team to determine whether there are NP exposure scenarios that are unique to or particularly important to academic settings (ongoing)
- Identify and/or develop science-based guidance re: how to mitigate risk of exposure to NPs to individuals performing tests in animals
- Develop & disseminate (online) training materials based on Nano Toolkit

Help us evaluate and improve the Nanotoolkit!

WE WANT YOU!

Email me at: hgodwin@ucla.edu