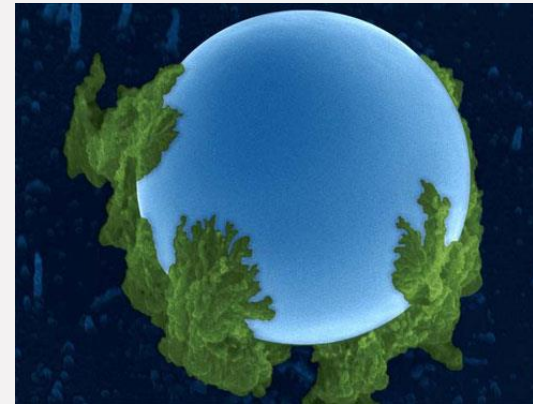
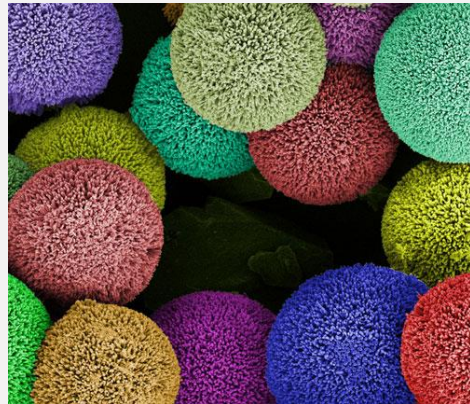


Nanotechnology and Health

Current Issues and Approaches for Risk Reduction

Spring into ACTion – ODLC/OHCOW H&S Conference
April 5, 2019



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Occupational Hygienist
OHCOW Eastern Clinic



Occupational
Health Clinics
for Ontario
Workers Inc.

Centres de
santé des
travailleurs (ses)
de l'Ontario Inc.

Prevention Through Intervention

Nanotechnology and Health - outline

- Nanotechnology Background Information
- Applications, Uses and Prevalence
- Health Concerns
- Exposure Assessment
- Controlling Exposures
- Nanotechnology and Health Network
- Moving Forward

Nanomaterials

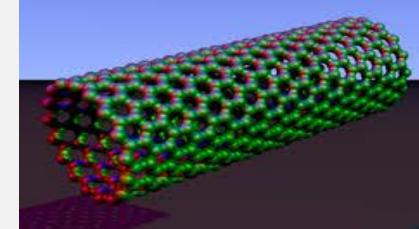
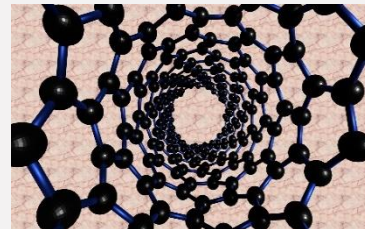
1. **Natural** Volcanoes, forest fire, ocean spray, viruses and biomolecules



1. **Incidental** Combustion engines, incinerators, jet engines, welding



2. **Engineered** Nano tubes, spheres and wires, metal oxides and polymers



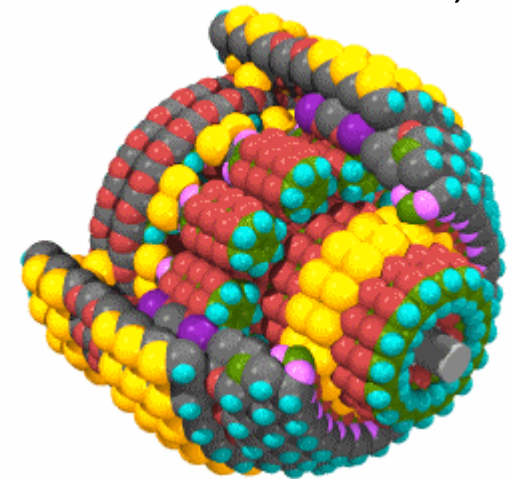
Nanotechnology

- **Nanotechnology**: ‘molecular manufacturing’

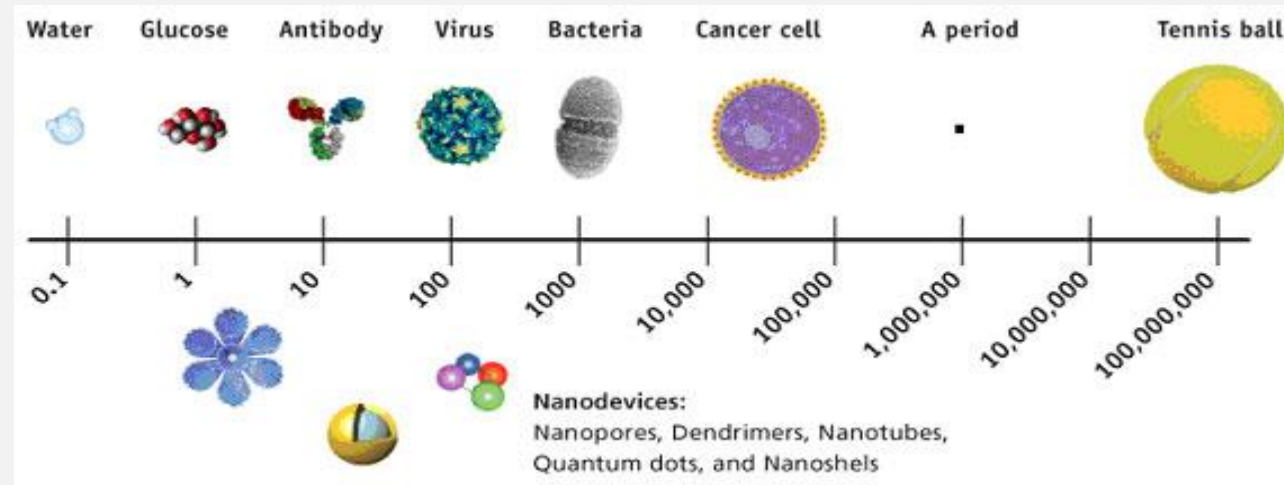
- Manipulation of matter at atomic, molecular and macromolecular scale to create new structures, materials and devices
- 1-100 nanometer (nm) scale length
- **Core**: synthesis of engineered nanoparticles

‘Revolution’ in science

- Discovery of nanoscale behaviour of elements and chemicals
 - **Quantum size effect**: “electronic properties of solids are altered with great reductions in particle size”
- Trillion dollar industry



The Nano Scale

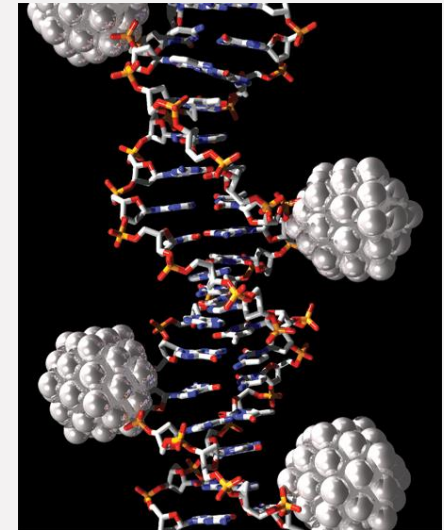


- Taken from: <http://www.fda.gov/consumer/updates/nanotech072507.html>
- One nanometer (nm) is one billionth (10^{-9}), of a meter or one billion nanometers equals one meter
- One million times smaller than the tennis ball

Nanoparticles: many shapes, many chemistries

Not all nanoparticles are the same!

- Unique physicochemical properties of nanoparticles produce **unique bioactivity**
- Understanding the relationship between nanoparticle properties & bioactivity is important for predicting relative pathogenicity
- Physicochemical properties
 - **Particle Size**
 - **Particle Shape**
 - **Oxidant Generation Capacity**
 - **Surface Functionalization**
 - **Rate of Dissolution**





INTRODUCTION

Nanotechnology Products Database (NPD) provides a reliable source of information about nanotechnology products, currently used in a broad range of industrial applications. ...

8368 PRODUCTS 2027 COMPANIES 56 COUNTRIES



Search in Products, Companies, Nanomaterials, Countries, Industries, Properties and ...

GO

ADVANCED SEARCH



Agriculture



Products	243
Companies	66
Countries	24

Automotive



Products	520
Companies	126
Countries	32

Construction



Products	607
Companies	233
Countries	31

Cosmetics



Products	767
Companies	187
Countries	27

Electronics



Products	2049
Companies	100
Countries	15

Environment



Products	520
Companies	213
Countries	31

Cosmetics



Products 767
Companies 187
Countries 27

Electronics



Products 2049
Companies 100
Countries 15

Environment



Products 520
Companies 213
Countries 31

Food



Products 324
Companies 124
Countries 23

Home Appliance



Products 245
Companies 71
Countries 18

Medicine



Products 963
Companies 291
Countries 36

Others



Products 399
Companies 168
Countries 27

Petroleum



Products 299
Companies 106
Countries 24

Printing



Products 137
Companies 56
Countries 20

Renewable Energies



Products 465
Companies 147
Countries 25

Sports and Fitness



Products 144
Companies 35
Countries 18

Textile

Recently Updated



Products 686
Companies 398
Countries 39

TEXTILE

Product Types

Show All



Belt

Products 2



Hunting pant

Products 1



Fiber Woven Article

Products 5



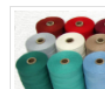
Vest

Products 2



Cleaning Cloth

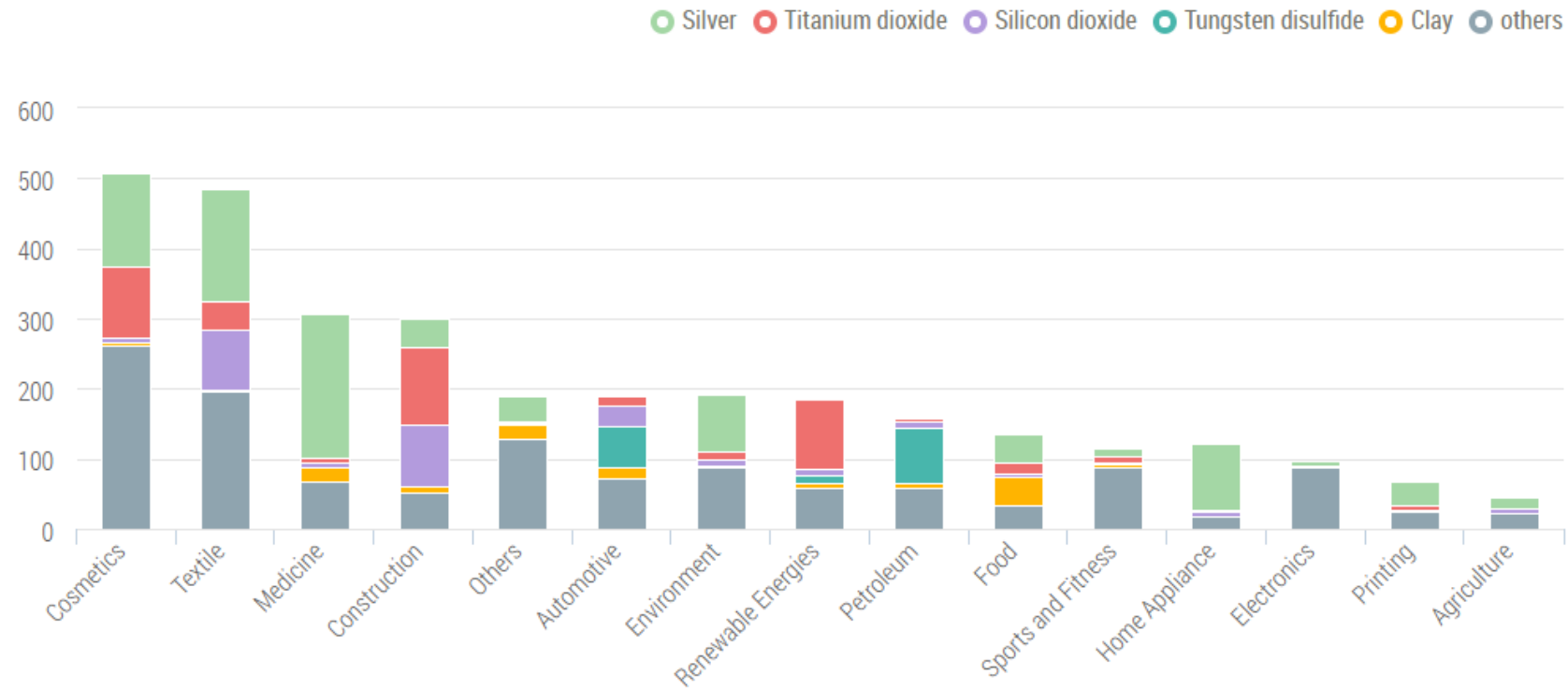
Products 7



Yarn

Products 16

No. Nanomaterials Used in Products by Industrial Divisions



Occupational Health Clinics for Ontario Workers Inc.

Prevention Through Intervention

Nanotechnology and Health

15 years of interest/concern ebbs and flows:

- NIOSH Nanotechnology Research Center 2004
- Concern flurry 10 years ago or so
- NIOSH workshops, investigations, programs, protocols
- CSA 2012 controlling engineered nanomaterial exposures
- NIOSH publications on exposure evaluation and programs 2012 to 2018
- Great deal of activity in Europe and elsewhere around the world

ODAP and the Nanotechnology Health Network (2016 – 2018)

(Occupational Disease Action Plan – Ontario)

- Origin – ODAP emerging issue, #10 priority ranking 2016 (top 3: noise, diesel exhaust, allergens/irritants)
- OHCOW Eastern Clinic strategy/brainstorming session early 2017
- CSA technical committee membership – many in Ottawa region
- Bi-monthly meetings – plus smaller sub-group meetings for specific issues
- eCourse – development with CCOHS and launched October 2018)

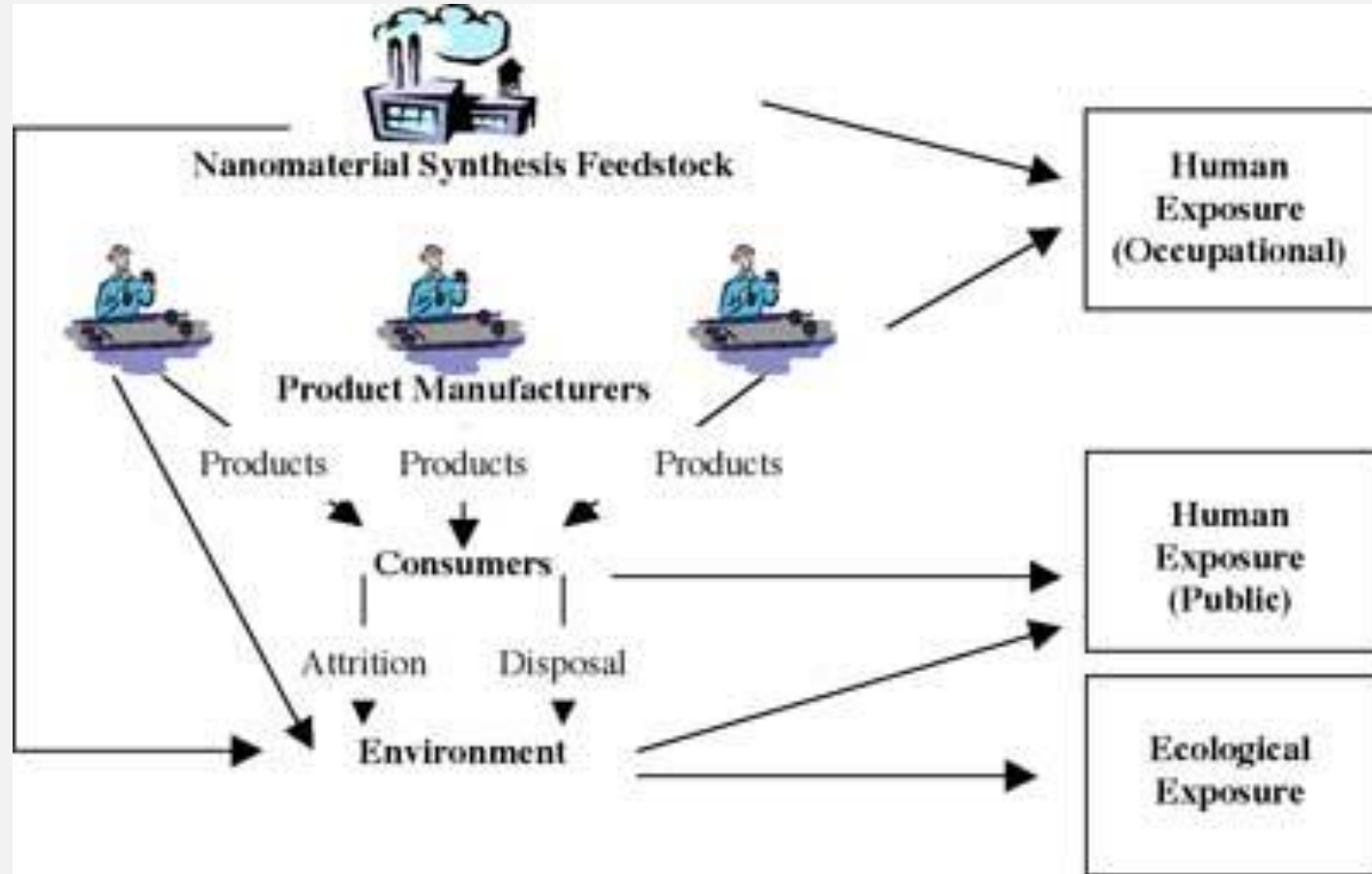
Nano Health Concerns

- Airborne nanoparticles can be inhaled and deposit in the respiratory tract
- Specific type of nanomaterial – a carbon multi-walled carbon nanotube (specifically MWCNT-7) with dimensions similar to asbestos is classified (2017) by IARC as possibly carcinogenic to humans (2B)
- Inhaled nanoparticles may enter the bloodstream and translocated to other organs
- Certain nanomaterials can cause rapid and persistent pulmonary fibrosis and cardiovascular dysfunction
- Can migrate along the olfactory nerve into the brain

Precautionary Principle

a principle that posits that the absence of full scientific certainty should not be used as a reason for postponing decisions and cost-effective measures where there is a risk of serious or irreversible harm. In circumstances of scientific uncertainty, the precautionary principle ***assumes the need to take prudent action in the face of potentially serious risk , without having to await the completion of further scientific research.***

Nano Exposures



Nano Exposure Assessment

- Air Monitoring (direct reading equipment and lab analysis)
- Surface wipe sampling (for product and catalysts)
- Control Banding (qualitative or semi-quantitative risk evaluation technique used to provide easy to understand and practical approach to controlling exposures)



Working with Engineered Nanoparticles

Certain workplace tasks may increase risk of exposure:

- Nanoparticles in liquid media w/o adequate PPE (skin)
- Nanomaterials in liquid involving agitation (droplets)
- Mechanical disruption of nanomaterials (aerosolization)
- Handling nanostructured powders (aerosolization)
- Nanoparticles generation in gaseous phase in non-enclosed systems (aerosolization)
- Maintenance on equipment / processes; cleaning spills or waste materials
- Cleaning dust collection systems (skin & inhalation)

Nano Control Measures

- Engineering control (LEV, Class III Biological Safety Cabinet, HEPA filter with greater than 99.97% efficiency for most nano particles enclosures procedures)
- Elimination (for highly toxic substances)
- Substitution (use of liquid instead of powders)
- Administrative control (worker awareness, purchasing controls, wet processes, sticky mats/gowning)
- Personal Protective Equipment (PAPR with HEPA, coveralls for skin protection)
- Control Banding
- Medical/Health Surveillance

Regulatory Situation

Challenges:

- A lack of reliable information about the presence of nanomaterials in the marketplace
- A lack of validated instrumentation and methodological approaches for detection and quantification of the presence of nanomaterials in complex biological and environmental media
- Consideration of the impact of physicochemical properties of nanomaterials on their effects and environmental fate (e.g., fullerenes vs CNTs vs graphene)
- A lack of validated test procedures that could be widely implemented for regulatory decisions (OECD validated guidelines/guidance)

Regulatory Situation

Next Steps:

- Fill data gaps required for prioritization (comprehensive literature searches on human health hazard data gaps, follow-up with survey respondents with request for further information (ongoing))
- Identify outstanding data gaps & establish strategy to fill gaps
- Complete Prioritization of 53 CAS RNs
- Develop Risk Assessment Framework
- Consultation with stakeholders on Risk Assessment Framework

Nanotechnology and Health Network (NHN)

Networking group that gathers and shares information and facilitates knowledge transfer on the topic of nanotechnology and health to workers and workplaces in Ontario

Intent is to ensure sufficient knowledge is available to establish and maintain adequate controls for potential exposures where nanomaterials are present and handled/manipulated

The group is a mix of technical experts (e.g. CSA/ISO group members, researchers, regulators etc.) and also representatives that are be directly associated with the workplace operations (unions, health and safety representatives, facility management, etc.)

NHN Representation

Labour

Unifor, Public Service Alliance of Canada, Canadian Union of Public Servants, Canadian Association of University Teachers, Canadian Labour Congress, District Labour Councils

Research/Regulatory

Health Canada, National Research Council, Natural Resources Canada, Occupational Cancer Research Centre, Canadian Centre for Occupational Health and Safety, Ontario Ministry of Labour

Prevention

Workplace Safety and Prevention Services, Infrastructure Health and Safety Association, Public Service Health and Safety Association, Workplace Safety North, Workers Health and Safety Centre, OHCOW

NHN Priorities

- Identify methods for identification of specific industries, organizations and operations that produce/use/manipulate nanomaterials
- Strategy for prioritizing identified groups (who are most vulnerable?)
- Strategy for communicating prioritized groups to discuss/evaluate current practices and control measures
- Establishing a process for evaluation and reporting on findings
 - Promote eCourse, identify, control (engineer, purchasing), assess, monitor hazard --- JHSC
 - Infographic and Podcasts (worker, expert, regulator) via CCOHS
 - Further identification and specific targeting of vulnerable groups

Moving Forward:

CCOHS/OHCOW

20-minute on-line awareness course (free to participants)



Also pursuing a CCOHS infographic and podcast (with subject matter expert, worker, regulator)



Canadian Centre for Occupational Health and Safety

www.ccohs.ca



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> Nanotechnology and Health **NEW! FREE!**

Gain an understanding of nanotechnology to help identify and safely control sources and products containing nanomaterials in your workplace.



Language: English | French

NOTE: This course is being offered for awareness purposes only. A certificate of completion will not be provided.

REGISTER:

VIEW COURSE

(opens in a new window)

Course Details

Format: e-Course

Duration: 30 minutes

Language: English/French

Course Description

Nanotechnology is a broad name given to a wide range of technologies and materials that create, manipulate, or use particles of an extremely small size – roughly between 1 and 100 nanometres (nm). A nanometre is 1 billionth of a metre.

These nanomaterials can be both naturally occurring and man-made, and workers can be exposed during manufacturing (handling powders, performing maintenance, machining, sanding) and by use of many consumer products (such as computer screen coatings, sunscreen, and cosmetics).

This awareness course discusses nanomaterials that may be found in Canadian workplaces, the potential health hazards they present, and how workers can be protected.

Topics include:

- Defining nanotechnology
- Nanomaterials and how they are made
- Are nanomaterials a health hazard?
- Areas and activities where exposure can occur
- Controlling/eliminating worker exposure to nanomaterials
- The role of the health and safety committee

<https://www.ccohs.ca/products/courses/nanotechnology/>

Nanotechnology and Health

Section 6 - Controls

What should be done to control or eliminate worker exposure? ▶

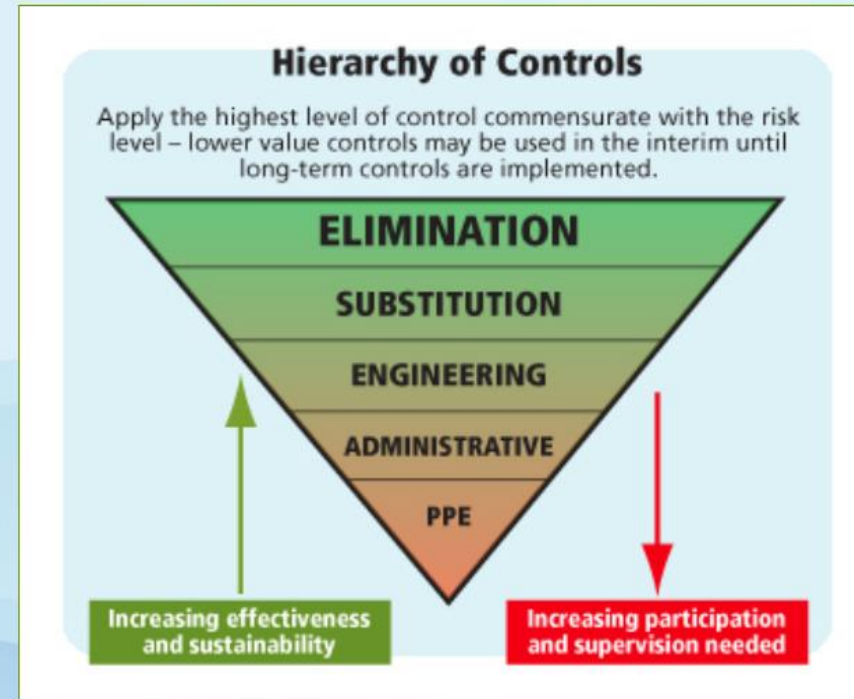
To control these exposures, use the hierarchy of control principles. There are four main methods of control which should be considered in the design phase, and in this order:

- Elimination (including substitution)
- Engineering controls
- Administrative controls
- Personal protective equipment

First, determine if you can eliminate or substitute.

For example, determine if it is possible to:

- Not use the nanomaterial at all (eliminate)
- Replace the nanomaterial with a "normal" sized particle that has known information about its hazards and risks (substitute)
- Use another form of the nanomaterial that is less likely to cause exposure, such as a liquid instead of dry powder (substitute)



NIOSH Poster a Worker Guide to Prevent Nano Exposures

NTRC NANOTECHNOLOGY
RESEARCH
CENTER

Controlling Health Hazards When Working with Nanomaterials: Questions to Ask Before You Start

Here are some questions you should ask yourself before starting work with nanomaterials.

Here are some options you can use to reduce exposures to nanomaterials in the workplace. These options correspond with the questions on the left.

(1) FORM

Have you done a job hazard analysis? What is the physical form of the nanomaterial? How much are you using? Can you reduce exposure to the nanomaterial by changing its form (for example, putting powder into a solution) or reducing the amount you are using?

DRY POWDER (typically highest potential for exposure)

SUSPENDED IN LIQUID

PHYSICALLY BOUND/ ENCAPSULATED (typically lowest potential for exposure)

(2) WORK ACTIVITY

How are you using the nanomaterial? Could the work activity cause exposure? Is the likelihood of exposure low or high? Can you change the way you do the activity to reduce the exposure?

Applies to Dry Powder Nanomaterials

- Higher potential for exposure: Dumping bags of powder, bagging or sieving of products
- Lower potential for exposure: Scooping/weighing of product, transporting containers with light surface contamination or closed barrels/bottles/bags

Applies to Nanomaterial Suspended in Liquids

- Higher potential for exposure: Spraying, open top sonication, producing a mist
- Lower potential for exposure: Cleaning up a spill, pipetting small amounts, brushing

Applies to Physically Bound/Encapsulated Nanomaterial

- Higher potential for exposure: Cutting, grinding, sanding, drilling, abrasive blasting, thermal release
- Lower potential for exposure: Manual cutting and sanding, painting with a roller or brush

(3) ENGINEERING CONTROLS

Based on the form and the work activity, what engineering controls will be effective? What are the key design and operational requirements for the control? How does the non-nanomaterial base material or liquid affect exposure?

Applies to Dry Powder Nanomaterials

- Chemical fume hood
- Glove box
- Nanomaterial handling enclosure
- Ventilated bagging or dumping stations
- High-efficiency particulate air (HEPA)-filtered local exhaust ventilation

Applies to Nanomaterial Suspended in Liquids

- Chemical fume hood
- Glove box
- Nanomaterial handling enclosure
- Local exhaust ventilation
- Ventilated spray booth

Applies to Physically Bound/Encapsulated Nanomaterial

- Chemical fume hood
- Glove box
- Local exhaust ventilation
- Wet cutting/machining
- Ventilated tool shroud
- Blasting cabinet
- Downdraft table

(4) ADMINISTRATIVE CONTROLS

Have you considered the role of administrative controls? Have you set up a plan for waste management? Have you considered what to do in case of a spill or how you will maintain equipment?

Applies to All Nanomaterial Forms


- Establish a chemical hygiene plan
- Perform routine housekeeping
- Train workers
- Use signs and labels
- Restrict access to areas where nanomaterials are used
- Handle and dispose of all waste materials (including cleaning materials/gloves) in compliance with all applicable federal, state, and local regulations
- Use sealed/closed bags or containers, and secondary containment
- Label containers, such as "contains nanoscale titanium dioxide"
- Wet wipe or use a HEPA-filtered vacuum
- Do not dry sweep or use compressed air
- Incorporate nanomaterial safety into existing programs such as hazard communication

(5) PERSONAL PROTECTIVE EQUIPMENT

If the measures above do not effectively control the hazard, what personal protective equipment can be used? Have you considered personal protective equipment for the non-nanomaterial base material or liquid?

Applies to All Nanomaterial Forms

- Nitrile or chemical resistant gloves
- Lab coat or coveralls
- Safety glasses, goggles, or face shield
- Respiratory protection when indicated and engineering controls cannot control exposures, and in accordance with federal regulations (29 CFR 1910.134)
- NIOSH guidance on respirators can be found at www.cdc.gov/niosh/topics/respirators/
- Use personal protective equipment during spill cleanups and equipment maintenance

 Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Are you Interested in learning more about how you can safely work with nanomaterials or want to stay up-to-date on nanotechnology safety? See the NIOSH NTRC website for more information and links to guidance documents: www.cdc.gov/niosh/topics/nanotech/

DHHS (NIOSH) Publication No. 2018-103 | February 2018
<https://doi.org/10.26616/NIOSH PUB2018103>

CSA Z12885-12

Nanotechnologies — Exposure control program for engineered nanomaterials in occupational settings

Employee Services and Development Canada
(ESDC)

ENGINEERED NANOPARTICLES
Health and Safety Considerations

Resources

- <http://www.ccohs.ca/oshanswers/chemicals/nanotechnology.html>
- <https://www.canada.ca/en/health-canada/services/science-research/emerging-technology/nanotechnology.html>
- <http://www.cdc.gov/niosh/topics/nanotech/>
- www.safenano.org/knowledgebase/guidance/safehandling/
- <http://nano.gov/>
- <http://GoodNanoGuide.org>
- http://www.osha.gov/dsg/nanotechnology/nanotech_standards.html
- www.nanowerk.com
- www.controlbanding.net
- www.coshh-essentials.org.uk
- <https://product.statnano.com>

Summary

- Identification and awareness in workplaces is required
- Although health effects are not fully known, enough to support the precautionary principle
- Ensure products and processes are identified, awareness and training in place
- Information on recommended control measures is established (wide variety of resources available) based on exposure assessment and control banding



nano eye drops – nanopolymers for vision correction after laser eye surgery!

https://www.youtube.com/watch?v=fvKOKIE_PcA