

NANO-SAFETY: What workers need to know

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Webinar ▪ August 20, 2014



Webinar will cover...

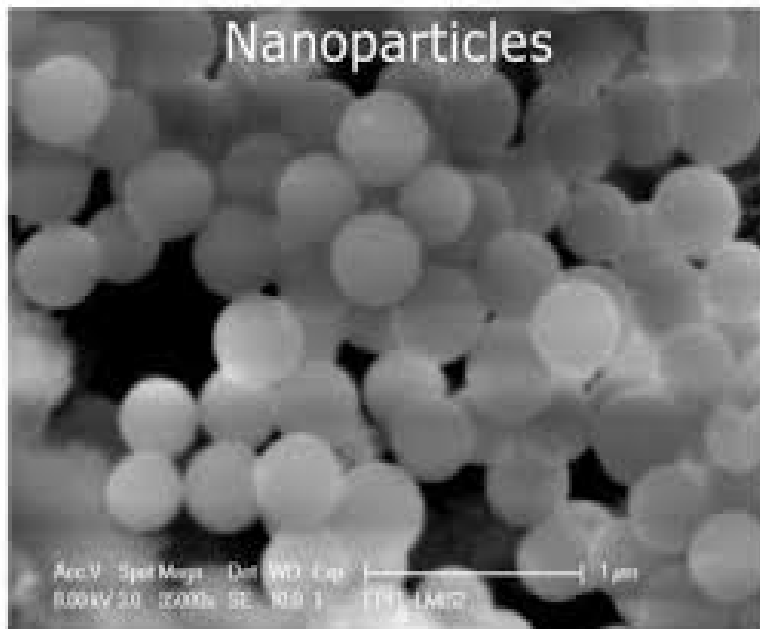
- The future of nanotechnology
- The potential hazards of nanoparticles
- Behaving Safely
- Laboratory practices for workers
- Resources for better understanding the safety of nanoparticles



Nuclear Age



Nano Age



THE FUTURE OF NANOTECHNOLOGY



- By 2020, there will be 6 million workers in nanoscience and manufacturing worldwide and 2 million of those jobs expected to be in the U.S.¹
- Nanotechnology will bring new innovations which will change society.
- We as people still have problems handling technology in moral and ethical manner to benefit human kind.

The future of Nanotechnology

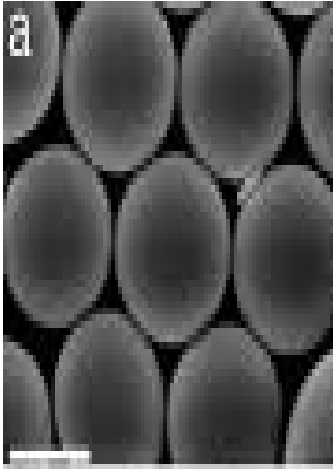


¹ Roco, M. C. (2011). Journal of nanoparticle research, 13, 427-445.

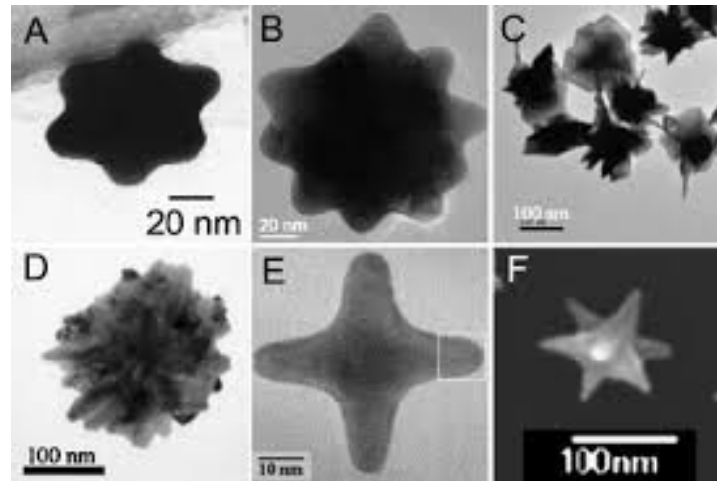
THE POTENTIAL HAZARDS OF NANOPARTICLES



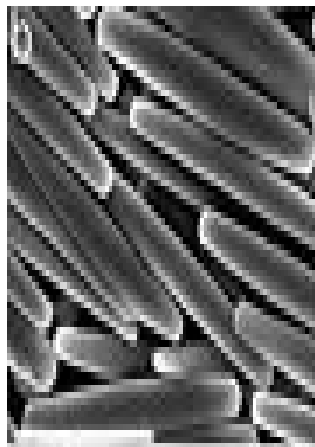
Different Shapes of Nanoparticles



Spheres



Other Geometric Shapes



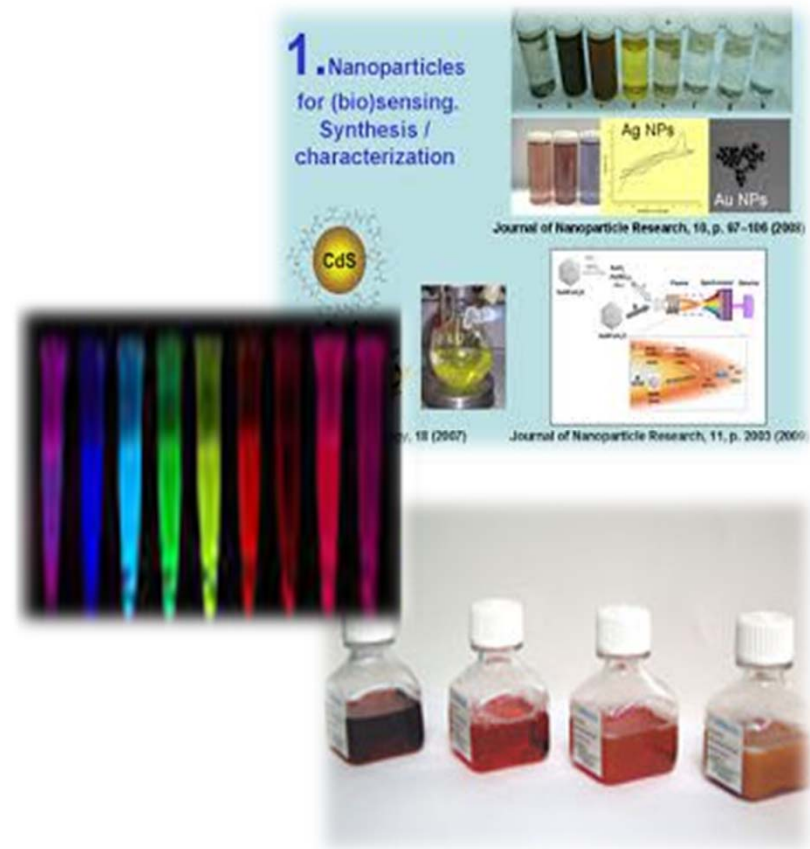
Rods



Tubes

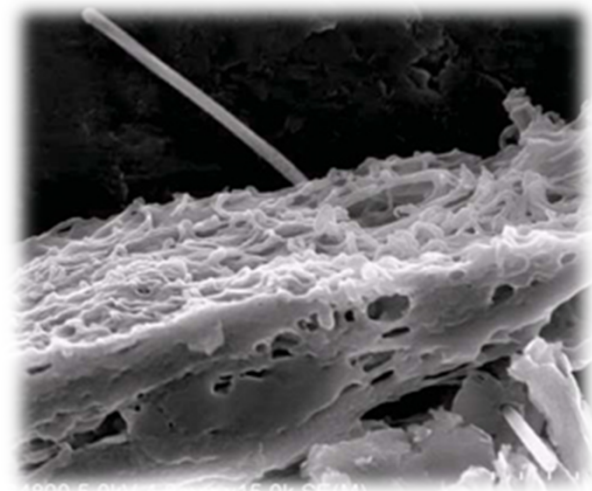
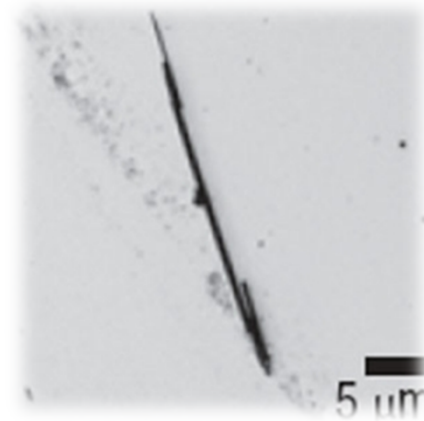
- There are some unknowns about nanoparticles in terms of their characterization
- There is no or little research to determine if different size nanoparticles have the same properties
- This may proposed a problem if scientists do not know if different size nanoparticles have different reactions to the human body

The Potential Hazards of Nanoparticles



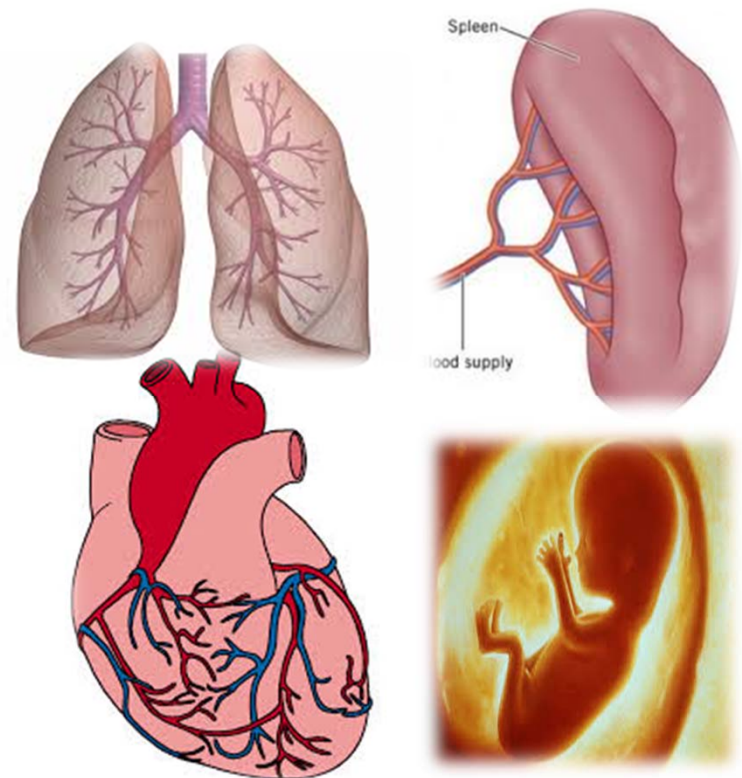
The Potential Hazards of Nanoparticles

- Researchers found that carbon nanotubes (multi-walled) In addition to the early-stage non-cancer lung effects in animals, some studies in cells or animals have shown genotoxic or carcinogenic effects²
- Single-walled carbon nanotubes, for example, can be manufactured via several different processes which can generate products with different physical and chemical properties
- It is **unclear** whether existing test methods for physical and chemical properties are sufficient for nanomaterials characterization in order to assess their risk and to determine their exposure and hazard. It is clear, however, that properties such as boiling point are insufficient
- Studies have found that carbon nanotubes is just as dangerous as Asbestos



The Potential Hazards of Nanoparticles

- Inhaled nanoparticles can deposit in the lungs and then potentially move to other organs such as the brain, the liver, and the **spleen**, and possibly the **fetus** in pregnant women. Some materials could become toxic if they are inhaled in the form of nanoparticles. Inhaled nanoparticles may cause **lung** inflammation and **heart** problems⁴



⁴ EUROPA (2013). Public health: Nanotechnologies. http://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies/l-2/6-health-effects-nanoparticles.htm

BEHAVING SAFELY

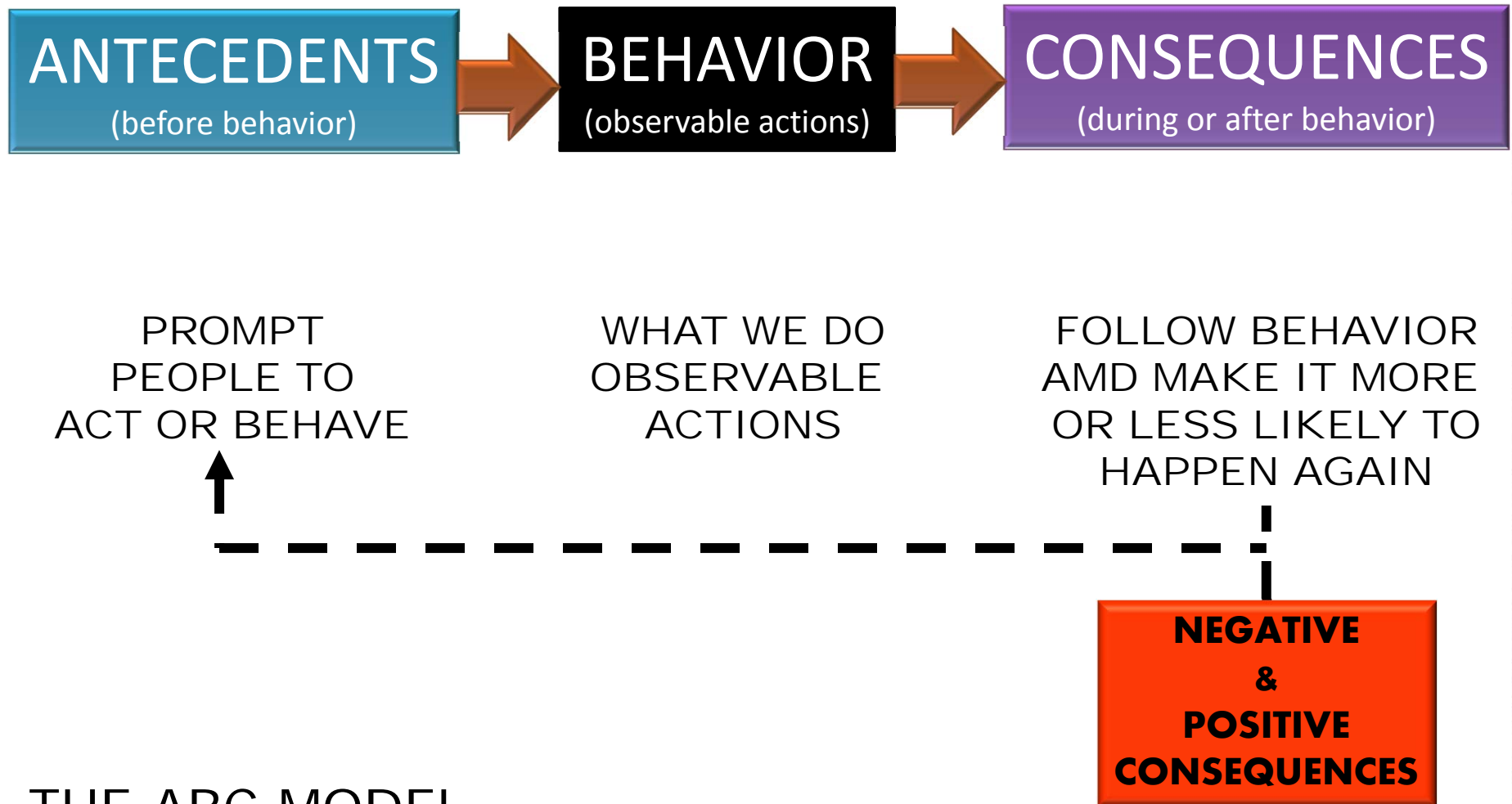


Behaving Safely⁵

- Performing a hazardous task safely is not enough, a person must *behave safely*
- Managers must a safety-minded attitude to provide a safe-environment
- Safety is even more focused and important when dealing with particles on the nano-relm
- Safety engineering is to assist workers to perform their jobs safely in manufacturing nanoparticles



Behaving Safely⁵



THE ABC MODEL

LABORATORY PRACTICES FOR WORKERS

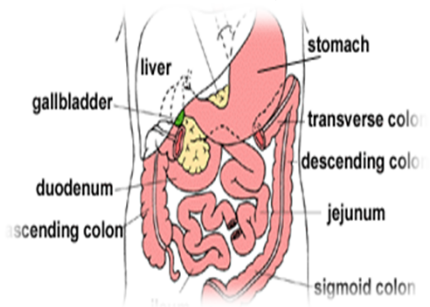


LABORATORY PRACTICES FOR WORKERS

- What are the exposure routes?
- MSDS (Material Safety Data Sheet)
- PPE (Personal Protective Equipment)
- Safety Engineering Equipment
- Disposal of nanoparticles/materials

Exposure

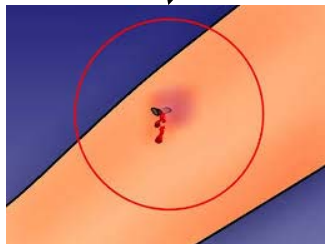
ROUTES Related human activities that lead to exposure



Ingestion



Contact with skin



Skin Puncture



Inhalation



Hand to Mouth

Material Safety Data Sheet (MSDS)

- A person who work with engineered nanoparticles should be reading the MSDS
- A person should be familiar with known chemical hazards
- **IF THERE IS NO MSDS ON THE PACKAGE DO NOT OPEN, RETURN TO MANUFACTURER!!!!**





Material Safety Data Sheet
SWeNT® SMW210
Multi-Walled Carbon Nanotube Nanohybrid

SECTION 1 PRODUCT IDENTIFICATION

PRODUCT NAME: Multi-Walled Carbon Nanotube Nanohybrid – SMW210

OTHER/GENERIC NAMES: SMW-NH, SMW200-NH, TMWNT-NH, TMWCNT-NH, Specialty Multi-Walled Nanotube Nanohybrid, Thin Multi-Walled Carbon Nanotube Nanohybrid

MANUFACTURER: SouthWest NanoTechnologies, Inc.
2501 Technology Place
Norman, OK 73071
+1 405.217.8388 – Tel
+1 405.217.8389 – Fax
<http://swentnano.com>
safety@swentnano.com

EMERGENCY PHONE: +1 405.613.2400

PRODUCT USE: This material has been approved for specific commercial uses under a US EPA TSCA Consent Order, apart from its non-restricted R&D use. Refer to section 15 for approved commercial uses and limitations/restrictions on its use.

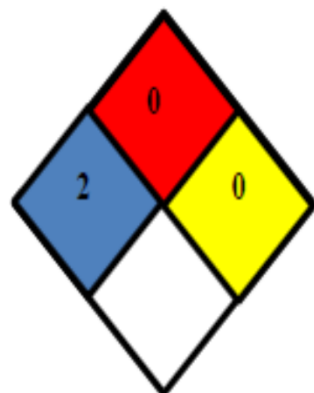
SECTION 2 COMPOSITION AND INFORMATION ON INGREDIENTS

<i>INGREDIENT NAME¹</i>	<i>CAS NUMBER</i>	<i>WEIGHT %</i>
Multi-Walled Carbon Nanotubes		70-80
Metallic impurities (including Molybdenum, Cobalt, Iron, Aluminum & Magnesium)	Various	20-30

This material is considered as hazardous under OSHA regulations.

¹ Trace impurities and additional material names not listed above may also appear in Section 15 towards the end of the MSDS. These materials may be listed for local "Right-To-Know" compliance and for other reasons.

SECTION 3 HAZARDS IDENTIFICATION



NFPA

Health Hazard	②
Fire Hazard	②
Reactivity	②

HMIS

EMERGENCY OVERVIEW: Product is a powder. May cause eye, skin and respiratory tract irritation. The complete physical and toxicological properties of this material have not been fully evaluated.

OSHA HAZARDS:

Irritant

GHS LABEL ELEMENTS

PICTOGRAMS



MSDS007: Revision 2.1

Current Issue Date: November 25, 2013

Previous Issue Date: July 6, 2012

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SIGNAL WORD	Warning
HAZARD STATEMENT(S)	
H319	Causes serious eye irritation
H335	May cause respiratory irritation
PRECAUTIONARY STATEMENT(S)	
P261	Avoid breathing dust/fume/gas/vapors/spray
P305+P351+P338	If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to. Continue rinsing.

POTENTIAL HEALTH HAZARDS

SKIN:	May cause skin irritation.
EYES:	May cause eye irritation.
INHALATION:	May cause irritation to the mucous membranes and upper respiratory tract. The product presents an increased inhalation hazard because of the small particle size.
INGESTION:	Not a probable route of exposure. This material may be harmful if swallowed (e.g. unintentional hand-to-mouth transfer).
DELAYED EFFECTS:	None known.

Ingredients found on one of the OSHA designated carcinogen lists are listed below.

<i>INGREDIENT NAME</i>	<i>NTP STATUS</i>	<i>IARC STATUS</i>	<i>OSHA LIST</i>	<i>ACGIH STATUS</i>
Cobalt Compounds	Group 2 ²	2B ³	None	A3 ⁴

² Reasonably anticipated to be human carcinogens

³ Possibly carcinogenic to humans

⁴ Confirmed animal carcinogen with unknown relevance to humans

SECTION 4 FIRST AID MEASURES

GENERAL:	Contaminated clothing should be removed and washed before reused.
SKIN:	Wash with soap and water. Get medical attention if irritation develops or persists.
EYES:	Flush eyes with plenty of water for at least 15 min. Get medical attention if irritation develops or persists.
INHALATION:	Remove to fresh air. If not breathing, give artificial respiration. Get medical attention if irritation develops or persists.
INGESTION:	If person is conscious, rinse mouth with water. Do not induce vomiting unless directed to do so by a physician. Get medical attention immediately.
ADVICE TO PHYSICIAN:	No specific advice, treat symptomatically.



Material Safety Data Sheet / Multi-Walled Carbon Nanotube Nanohybrid

LOWER FLAME LIMIT (VOLUME % IN AIR):	Not applicable.
FLAME PROPAGATION RATE (SOLIDS):	Not determined.
OSHA FLAMMABILITY CLASS:	Not determined.
DECOMPOSITION PRODUCTS:	Carbon Monoxide, Carbon Dioxide.
EXTINGUISHING MEDIA:	Water, Carbon Dioxide, Dry Chemical or Alcohol-Resistant Foam

UNUSUAL FIRE & EXPLOSION HAZARDS:

Airborne dust from the dried dispersion in an enclosed space and in the presence of an ignition source may constitute an explosion hazard.

SPECIAL FIRE FIGHTING PRECAUTIONS/INSTRUCTIONS

As in any fire, wear NIOSH/MSHA approved positive pressure self-contained breathing apparatus and full protective clothing, as combustion may produce hazardous fumes.

SECTION 6 ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR OTHER RELEASE:

Use appropriate personal protection during clean up (Section 8).

Avoid inhalation of powder, fume and vapor as well as skin or eye contact. Keep unprotected personnel away.

Extinguish all ignition sources. Avoid sparks, flames, heat and smoking.

Remove mechanically by a method that minimizes the generation of airborne dust (HEPA equipped vacuum, wet mopping, etc.).

Absorb material and place in appropriate closed containers for disposal. Do not allow spilled material or wash water to enter sewers, surface water, or ground water. Refer to section 13 for disposal information.

Spills and releases may have to be reported to Federal and/or Local authorities. See Section 15 regarding reporting requirements.

SECTION 7 HANDLING AND STORAGE

NORMAL HANDLING:

Always wear recommended personal protective equipment (Section 8).

Avoid formation of dust and aerosols. Keep in closed containers. Additional sealing may prevent accidental dust release.

Use local exhaust or general room/dilution ventilation sufficient to maintain exposure below permissible exposure limits (29 CFR 1910.1001 for asbestos). If possible, use in a closed well-ventilated area (e.g. fume hood).

PERSONAL PROTECTIVE EQUIPMENT



SKIN PROTECTION:

For any handling steps where the substance is in particulate form or in a suspension with pure water where the substance is not solubilized, the gloves must be comprised of material that successfully passes ASTM F-1671.

For any handling steps where the substance is part of a carrier liquid, other than the aqueous suspension noted in the previous paragraph, gloves must be comprised of material that successfully passes ASTM F-739 (continuous liquid contact method).

Gloves must be changed before they show degradation and before the designated breakthrough time for the carrier liquid (as determined by the ASTM F-739 testing or by the manufacturer).

Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with the product.



Material Safety Data Sheet / Multi-Walled Carbon Nanotubes

Wear full body clothing, impervious to the product.

EYE PROTECTION:

Wear chemical goggles that conform to ANSI Z87.1 under normal conditions. Wear a full-face shield if there is a potential for contact with splashed material.

RESPIRATORY PROTECTION:

If there is potential for inhalation of dust, vapors, or aerosols wear a full-face NIOSH approved respirator with N100 cartridges or better.

The respirator must be selected based on contamination levels and use conditions found in the workplace. Use conditions must not exceed the working limits of the respirator. The respirator must be used in accordance with the OSHA respiratory protection standard (29 CFR 1910.134).

HYGIENE MEASURES:

Keep away from foodstuffs, beverages and feed. Remove all soiled and contaminated material immediately. Wash hands before breaks and at the end of work.

ADDITIONAL RECOMMENDATIONS:

Provide safety showers and eyewash stations in close proximity to the work area.

Detailed information on handling carbon nanotubes may be found at the ASTM Standard E2535-07 "Std guide for Handling Unbound Engineered Nano-Scaled Particles in Occupational Settings" www.astm.org

OTHER EXPOSURE LIMITS FOR POTENTIAL DECOMPOSITION PRODUCTS: None.



Material Safety Data Sheet / Multi-Walled Carbon Nanotubes

INCOMPATIBILITIES/MATERIALS TO AVOID:

Strong oxidizing agents, acids & bases, Halogens, Interhalogens, Alkali metals, Chlorine trifluoride, Ethylene oxide, Halogenated hydrocarbon, Oxygen difluoride, Sodium mnitrate, Vinyl compounds.

HAZARDOUS DECOMPOSITION PRODUCTS:

Thermal decomposition products may include carbon monoxide, carbon dioxide and oxides of metallic ingredients (including molybdenum, cobalt, magnesium, aluminum and iron).

HAZARDOUS POLYMERIZATION:

Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION¹¹

IMMEDIATE (ACUTE) EFFECTS:

No data available.

DELAYED (SUBCHRONIC AND CHRONIC) EFFECTS:

No data available.

OTHER DATA:

None

¹¹ Toxicological information on carbon nanotubes may be found at the website of International Council on Nanotechnology at <http://cohesion.rice.edu/centersandinst/icon/>

SECTION 12 ENVIRONMENTAL INFORMATION¹²

No data available

¹² Information on ecological harms can be found at the website of International Council on Nanotechnology at <http://cohesion.rice.edu/centersandinst/icon/>

SECTION 13 DISPOSAL CONSIDERATIONS

RCRA

Not classified as RCRA hazardous waste

OTHER DISPOSAL CONSIDERATIONS:

Except from small R&D samples, disposal of this product is not allowed by federal, state and local government regulations. It must be destroyed in hazardous waste incinerator and special care should be taken not to be released in the water.

NOTE: The information offered here is for the product as shipped. Use and/or alterations to the product such as mixing with other materials may significantly change the characteristics of the material and alter the RCRA classification and the proper disposal method.

SECTION 14 TRANSPORTATION INFORMATION

US DOT HAZARD CLASS: Not regulated.

US DOT ID NUMBER: Not applicable.

For additional information on shipping regulations affecting this material, contact the information number found on Section 1.

SECTION 15 REGULATORY INFORMATION

TOXIC SUBSTANCES CONTROL ACT (TSCA)

TSCA INVENTORY STATUS:

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OTHER INFORMATION:

None.

DISCLAIMER:

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CAUTION! POTENTIAL HAZARDS OF THIS EXPERIMENTAL PRODUCT ARE UNKNOWN.

MANUFACTURED UNDER U.S. PATENT NOS. #6,333,016, #6,413,487, #6,955,800 AND INTERNATIONAL PATENT NO WO2011/009071, AS WELL AS OTHER PENDING PATENT APPLICATIONS IN THE U.S. AND AROUND THE WORLD.

PPE (Personal Protective Equipment)

The last line of defense for acting safely. PPE is a barrier to protect the body
And prevent leakage of particles

- Dermal exposure



- Inhalation exposure



Safety Engineering Controls



Glove Box



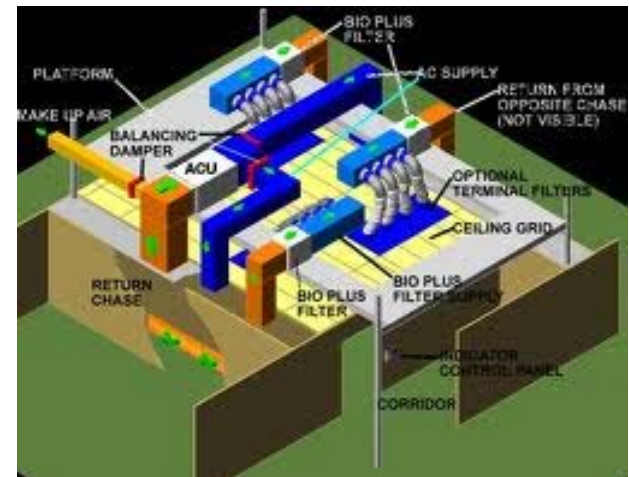
Clean Room



Fume Hood



Glove Bag



HVAC

Safety Engineering Controls

- Develop a Preventative Maintenance plan (PM)
 - This plan will help:
 - Maintain maximum protection
 - Meet or exceed the life of the warranty
 - Reduce human error



Disposal of⁶ Nanoparticles

- Spills must be cleaned up immediately with the use of HEPA-FILTER VACUUM equipment or wet wipe (towels) or the combination of two
- Gloves must be used
- If spills that may cause airborne nanoparticles, must use proper respiratory protection



Disposal of⁶ Nanoparticles

- If Storage in waste containers must be built to handle nanomaterials. The containers must be in good condition and prevent leaks
- Storage of nanomaterial in plastic bags labeled and color coded to ensure proper disposal
- **Must have a Waste Disposal Operations Procedures (WDOP) for workers**



Latest Safety Technology

■ Technical Data



“N type” respirators, has a median size of the test particle, by count, is 75 nm

According to a 2007 article in the *Nanotechnology Law Report*⁷, standard air filter Techniques were used on silver nano particles (3nm-20nm). Study revealed that particle penetration decreases continuously down to 3nm.

Although other engineered nanoparticles may behave differently in filter media. Some standard air filter techniques may not apply as more engineered nanoparticles are developed

⁷ <http://www.nanolawreport.com/2007/06/articles/will-standard-air-filtration-techniques-work-with-nanoparticles/#axzz3AlTs6pjw>

Resources for better understanding the safety of nanoparticles



- **NIOSH-CDC**

<http://www.cdc.gov/niosh/docs/2014-102/pdfs/2014-102.pdf>

- **OSHA**

<https://www.osha.gov/dsg/nanotechnology/nanotechnology.html>

- **EH&S-Berkley**

Campus<http://nano.berkeley.edu/research/73nanotech.pdf>

- **U.S. Department of Health and Human**

Services<http://ntp.niehs.nih.gov/results/nano/index.html>

- **United Kingdom**

<http://www3.imperial.ac.uk/safety/subjects/nanotechnology>

- **Penn State**

<http://www.ehs.psu.edu/occhealth/nanomaterials.cfm>

**For any questions, please
contact me @**

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