Introduction

Welcome to the course ***Nanotechnology Awareness OHS_HS239***. This course is designed as an introduction to nanomaterials – terms, history, types, property changes, uses, and concerns.

Objectives

At the end of this course, you should be able to:

- Identify basic nanomaterial (NM) terminology by matching the terms to their definitions,
- Classify the different types of nanomaterials (natural, incidental, and engineered),
- Name five out of ten products that currently use nanomaterials, and
- Choose three out of five issues that cause UAB Occupational Health & Safety (OH&S) and other entities concern when working with or using nanomaterials.

Terms and Definitions

Term	Definition
Nano	Greek for dwarf; very small; minute; super tiny; 1 nanometer (nm) = 0.000000001 meter (m); 1 nm = 10^{-9} m; 1nm = one billionth meter
Nano Measures	
Nanometer	One billionth of a meter
Nanosecond	One billionth of a second
Nanoliter	One billionth of a liter
Nano-object	Material with one, two, or three external dimensions in the size range from approximately 1-100 nm.
Nanomaterial	Nano-objects incorporated in a larger matrix or substrate
Nanotechnology	"Nanotechnology is the understanding, manipulation, and control of matter at dimensions of roughly 1 to 100 nanometers to produce new materials, devices, and structures." *OSHA definition*
Nanorobot	Now called a nanobot; an exceptional small autonomous, self-propelled machine that may reproduce

This nanobot example could be useful for military and police reconnaissance in the future. Smaller than a mosquito, they could penetrate places where humans, dogs, and current bots might not be able to go.

History of Nanomaterials

Pre-historic Man and Nanomaterials

When we think back to the beginning of time, we think about dinosaurs, dry land or oceans, extreme temperatures, cave people, and fire. But what does that have to do with nanomaterials?

Actually, nanoparticles existed in the smoke from man's first fires. These carbon-based nanoparticles allowed early mankind to draw on cave walls – prehistoric art that still exists today in caves located in southwestern France. The artwork is still as vivid as it was during the Paleolithic stage.

Naturally occurring nanomaterials existed in the ashes and smoke from the active volcanoes as well as the sea spray from the oceans.

The Middle Ages

During the Middle Ages, mankind began to tinker with nanomaterials quite by accident. Mixing sand and wood ash created stained glass colors. Then the powdered materials were added to the hot molten glass.

Somehow these artisans knew when superfine gold dust was added, a green or ruby red color would appear in the glass. Superfine chromium and iron oxide dust created green variations.

In the image shown here, modern artisans have learned how to mix silver nanoparticles with red clay to imitate the color red that matches some of the medieval stained glass pieces that still exists in some of the cathedrals today.

Steel makers during these times created a material strong enough to cut through rocks and then slice meat so thin you could see through it without wear and tear to the steel. Damascus steel has yet to be recreated in its exact molecular form.

Types of Nanomaterials

Naturally Occurring Nanomaterials

The historical type of nanomaterials are called *naturally occurring nanomaterials* – those that come from the earth – smoke, minerals, sea spray, etc.

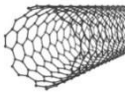
Incidental Nanomaterials

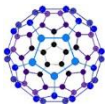
Unfortunately, mankind created other nanoparticles along the way – *incidental nanoparticles*. These are the byproducts of processes such as combustion and generated in an uncontrolled manner. Here are a few of them along with the diseases that come from continuing exposure:

Incidental Nanoparticles	Diseases
Diesel exhaust	Respiratory disease, cancer
Cooking smoke	Pneumonia, chronic respiratory disease, lung cancer
Welding fumes	Metal fume fever, infertility, benign pneumoconiosis (a disease of the lungs, characterized by fibrosis and caused by chronic inhalation of mineral dusts)
Sandblasting	Silicosis (lung fibrosis caused by inhalation of dust containing silica)
Industrial Emissions/Effluents (Waste)	Asthma, atherosclerosis, chronic obstructive pulmonary disease

Engineered Nanomaterials

Engineered nanomaterials are intentionally produced and designed with very specific properties related to shape, size and chemistry. Engineered nanomaterials are more well-defined than incidental nanomaterials. Incidental nanoparticles are far more variable having different shapes and sizes and composed of different elements.

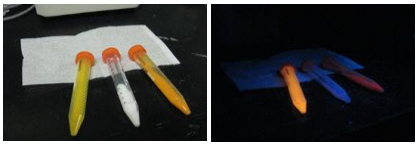




Well-known engineered nanomaterials are quantum dots (e.g., atoms, multi-molecular combinations), nanotubes, and buckyballs (i.e., a sphere that resembles a soccer ball).

Changes at the Nanoscale

When materials are nanosized, both physical and chemical properties change. The following changes can occur:



- Color (some will fluoresce as shown here in regular light and then no light)
- Melting temperature,
- Crystal structure,
- Chemical reactivity,
- Electrical conductivity,
- Magnetism, and
- Mechanical strength.

Solid pure gold is shiny, non-magnetic, melts at 1336 K, and is an impressive metal. However, when it is nanosized, it can be red or green in color, become magnetic at ~ 3 nm, lose conductivity at ~ 1-3 nm, and is explosive and catalytic.

Even though the famous Lycurgus Cup was made over 1,600 years ago, it still glows green when light is shined from the front, and red when lit from the back. (On display at The British Museum in London, England). Researchers use this technology even today.

Current Uses of Nanomaterials

Nanomaterials are everywhere these days. More than 1,300 commercial products have manufactured nanoparticles in them. Which ones affect your life every day?

Foods	Personal Care	Electronics	Environment and Sustainability	Biomedical and Health
M&Ms	Makeup (especially aging products)	Quantum computers	Pollutant scavengers	Antibacterial
Dentyne Gum	UV protection (sunscreen)	High density data storage	Waste water treatment	Antioxidants
Dunkin' Donuts	Toothpaste (white pigment)	Chemical and gas sensors	Pollution monitoring sensors	Wound dressings
Kraft American Singles Cheese	Dental fillings	High power magnets	Environmental catalysts	Drug controlled release
Pop-Tarts	Dental ceramics	Superplastic ceramics	Removal of environmental contaminants	Blood purification and tissue engineering
Oreos	Anti-stain clothing	Quantum lasers	New, more efficient spark plug (railplug beta)	Hypothermic treatment
Betty Crocker Mashed Potatoes	Self-cleaning clothes	Thinner, lower cost flat panel displays	Lighter, stronger airplane exoskeleton for saving gas and money due to longevity	Cancer therapy

Concerns

As you can see, nanoparticles are everywhere – in our food, personal and health care products, technology, etc. But what are the consequences of these nanomaterials on animals, humans, and the environment? *Unknown at this time*.

Another factor to consider will be what happens to the nanomaterial inside the body? We know that materials that are nanosized can change physical and chemical properties. Studies have shown that these nanoparticles can translocate to other organs once inside the body. So what is the outcome? *Unknown at this time.*

What will be the impact of chronic exposure to scientists in labs? Will the potential damage be significant? How much nanomaterial would be needed to cause appreciable harm? How well will the human body and the environment be able to deal with the nanomaterials and recover? *Unknown at this time.*

Next Steps

With so many questions with undetermined answers, how can we protect ourselves, our co-workers, and the environment from harm?

If you are working with nanomaterials at UAB, you are required to complete the next course, ***Working Safely with Nanotechnology OHS_HS240***. It is by *assignment only*, and it is a two-part course. There is an online component followed by an on-site visit from OH&S. The course covers how to work safely with nanomaterials and the policies and procedures you will need to know and apply on a daily basis. If you are using nanomaterials in research at UAB, you are required to take other courses as well:

- Biosafety Cabinets and Fume Hoods OHS_BIO304, and
- Chemical Safety OHS_CS101.

Both BIO304 and CS101 must have been ***completed within the last three (3) years***.

Conclusion

This concludes the ***Nanotechnology Awareness Course OHS_HS239***. If you have not taken the assessment, please do so now. A score of 90% or higher is required to pass. You will have two opportunities to pass the assessment. If you fail both times, it is considered a failed course and will appear on your transcript as such.

If you have any questions or concerns or need to be assigned the next course, please contact Occupation Health & Safety (OH&S) at 934-2487.

Want to Learn More?

OH&S has many training courses available to all UAB active employees and students. This includes topics such as in depth radiation training, biosafety, bloodborne pathogens, chemical safety, controlled substances, building life safety, hazardous and medical waste, universal waste, PPE, hazard communication , etc.

We have a **decision tree** to assist you in choosing the right course to match the knowledge/skills you may need at work every day as well.

If you have any questions or comments, please feel free to contact OH&S.