A Trainer's Approach to Increase Awareness of Engineered Nanomaterials in Construction

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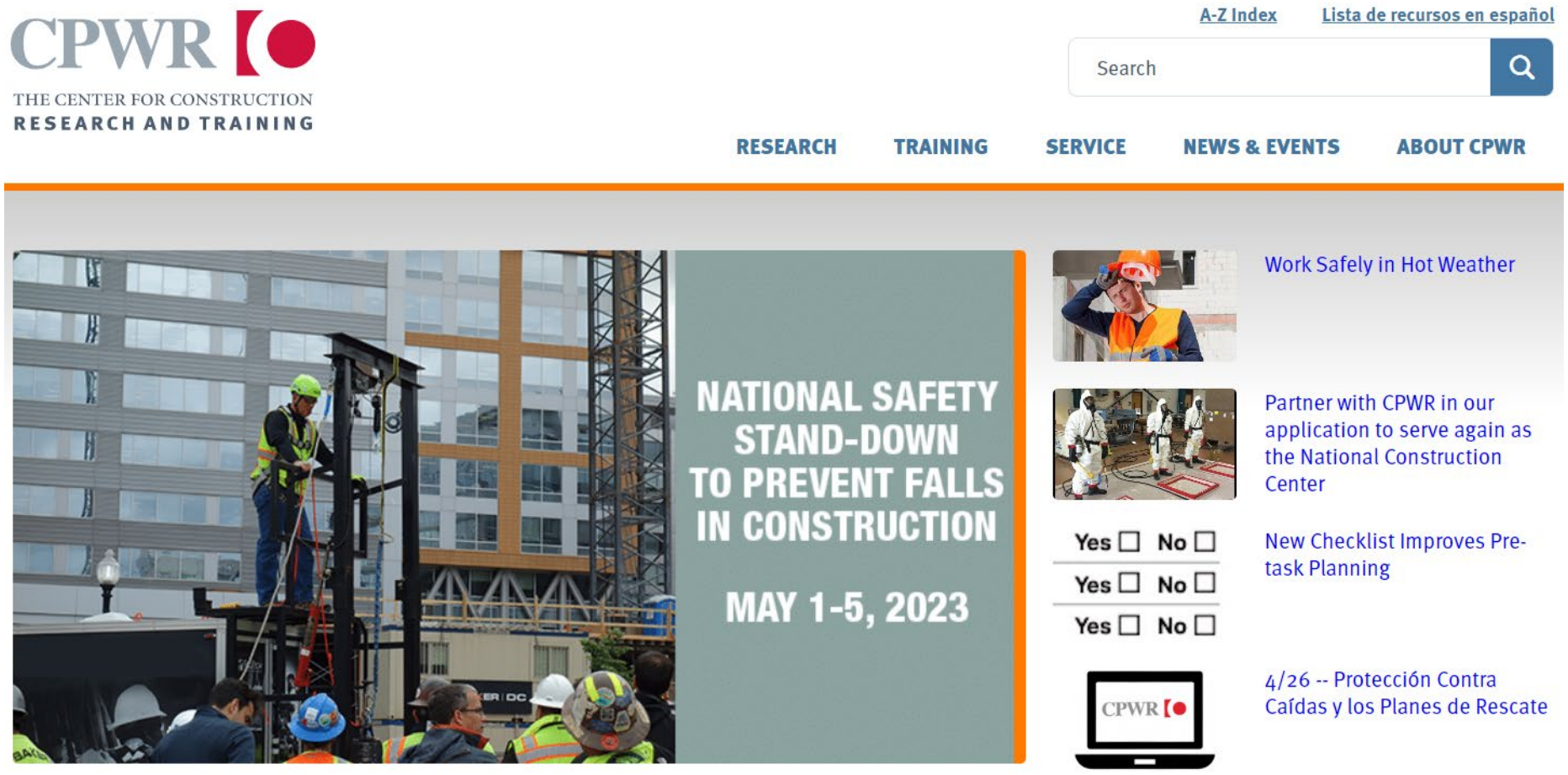
CPWR
THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Overview of today's session:

1. Background on CPWR and our training on nano
2. Review course learning objectives and technical content
3. Opportunities to share and discuss throughout

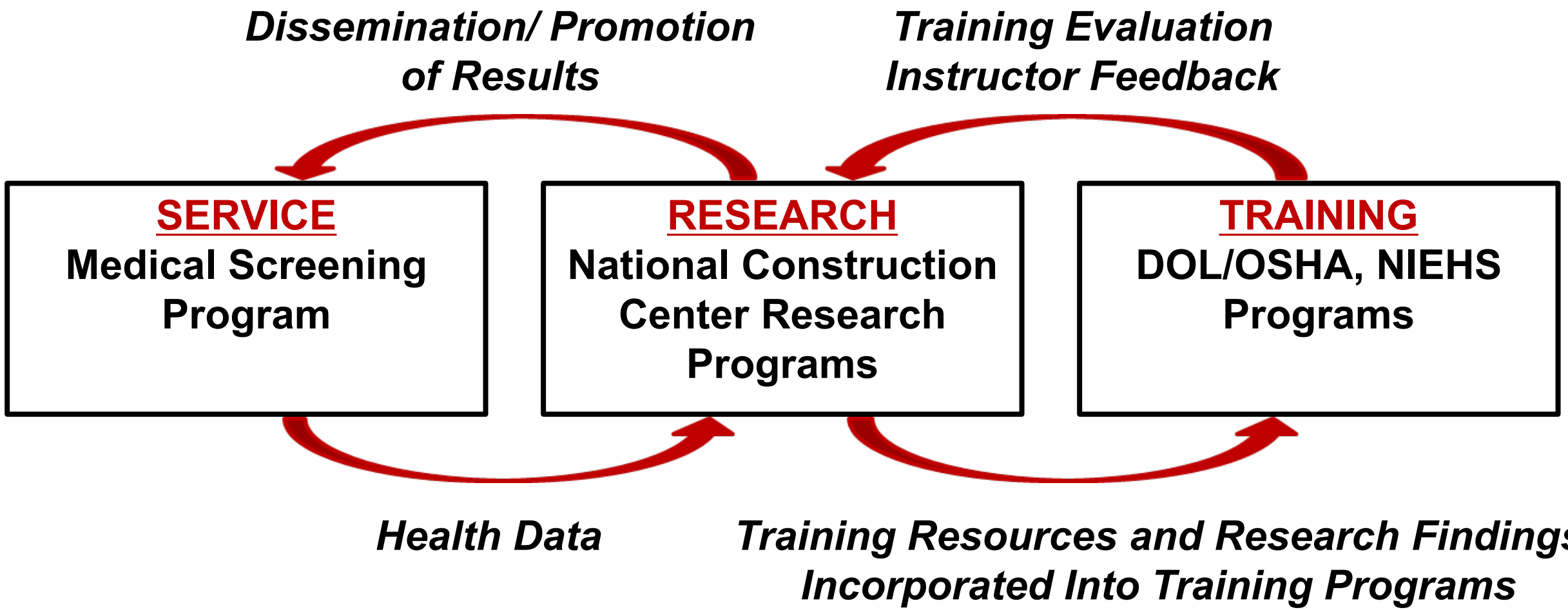
CPWR has served as the NIOSH National Construction Center since 1990



- Non-profit organization
- Created by **N**orth **A**merica's **B**uilding **T**rades **U**nions

www.cpwr.com

CPWR's research, training, and service programs are integrated



I’m a researcher who recognizes the importance of what you do as trainers

We’re all here to share and learn from each other

I’m thankful to work with a great team on the curriculum development and delivery

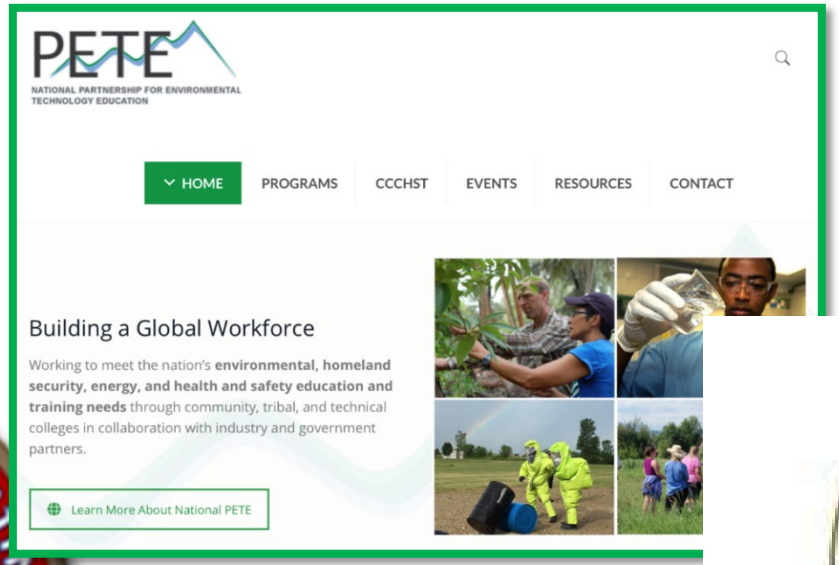
Bruce Lippy, PhD, CIH, CSP, FAIHA
CPWR Consultant

Sara Brooks, MPH
CPWR Industrial Hygienist

Bill Kojola, MS
AFL-CIO (retired)

We use a train-the-trainer approach and tailor the content to different audiences

IUPAT / FTI



National PETE
CCCHST

IUOE

Insulators

We designed a group exercise for CCCHST based on an actual event

A truck transporting several bags each holding 750 kg (1650 lbs) of photocatalytic nano titanium dioxide (TiO_2) lost its cargo. Unprotected road maintenance workers did the clean up.

NIOSH classified nano-sized TiO_2 as a potential occupational carcinogen and recommended an exposure limit 8x lower compared to larger forms of TiO_2.

Responding to an accidental spill of ENMs: Participants used documents, emergency response apps, and what they learned in the course to answer these questions

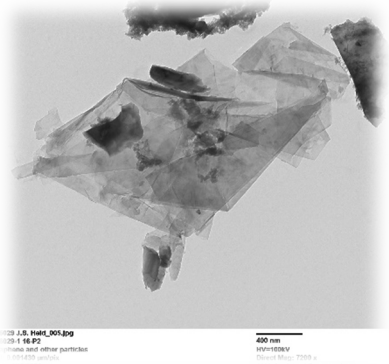
1. What actions would you take if you were the first responding unit on site?
2. Would you have highway maintenance crews doing the cleanup?
3. What cleanup methods would you use? What PPE?
4. Is there a fire risk?
5. What would you tell the school and businesses nearby to do?
6. What would you tell the local press?

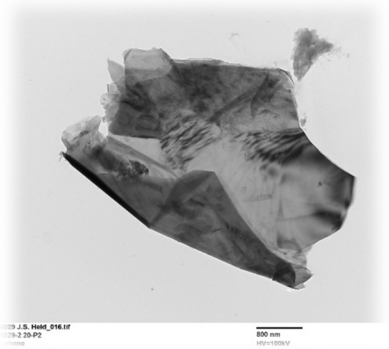
SDS group exercises highlight deficiencies in hazcom for nano

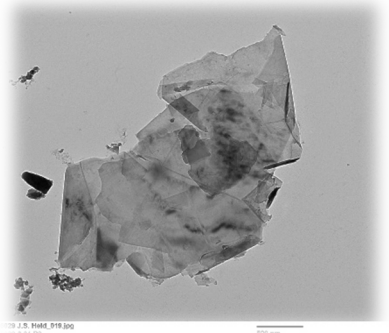
Participatory approaches have worked well for us along with assertion-evidence

Is anyone familiar with the assertion-evidence approach and willing to explain?

The training is updated to reflect current research including studies we conduct







Let’s pause for discussion

What strategies and resources do you use to stay on top of new information and evolving best practices?

After this session you will be able to:

- Explain nanotechnology using visual aids and familiar concepts
- List 3 applications of engineered nanomaterials in construction
- Discuss what is known about risks and controls
- Use information about engineered nanomaterials in your courses

Explain nanotechnology using visual aids and familiar concepts

Objective 1

What is nanotechnology?

Science, engineering, and technology conducted at the size range of about 1 to 100 nanometers

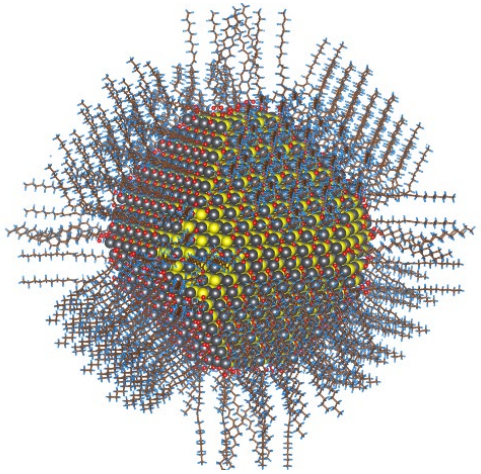
https://www.nano.gov/nanotech-101/what/definition

A yard is roughly a meter

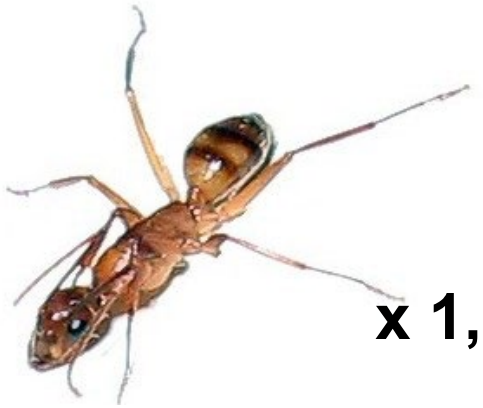
Think about cutting that into a billion sections

Getting a handle on size

This nanoparticle is one million times smaller than an a



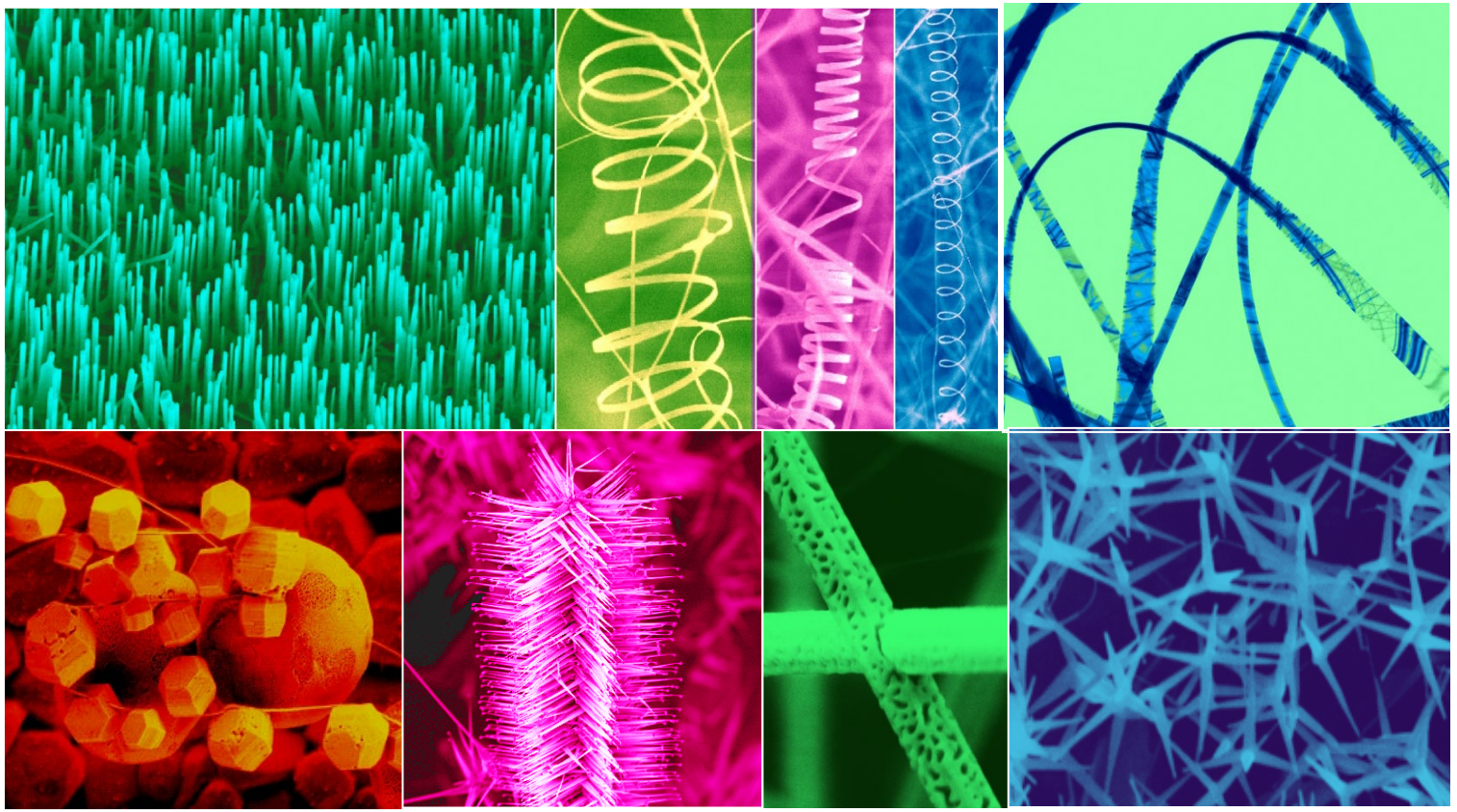
x 1,000,00



x 1,000,000

Indy 500 racetrack, 2.5 miles long.

What is an *engineered* nanomaterial (ENM)?

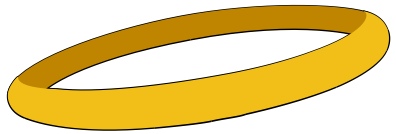


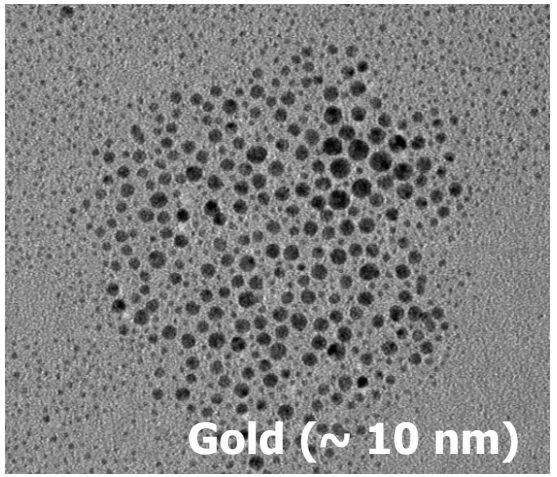
An object 1 to 100 nanometers in at least 1 dimension created by human beings for some purpose

Image courtesy Dr. Zhong Wang, Georgia Tech

Welding generates fumes that contain nanoparticles. Are they engineered nanoparticles?

Can nanomaterials differ from larger forms of the same material?

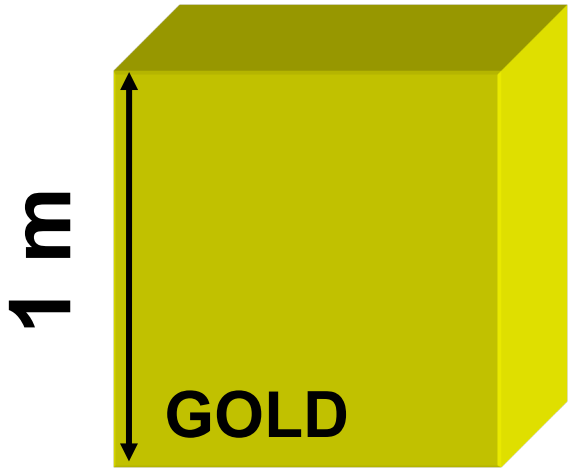


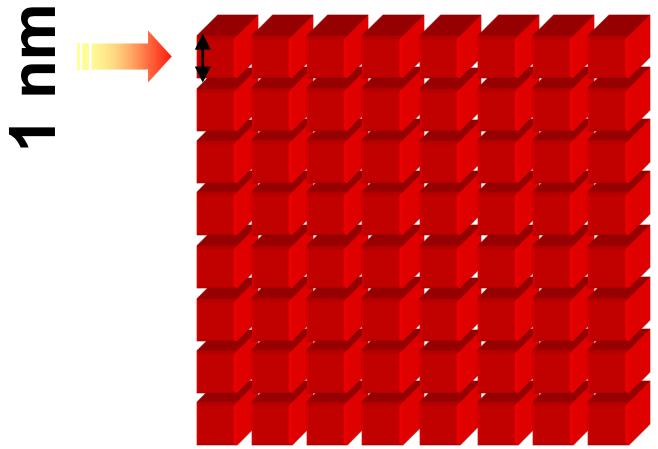


Bulk gold is yellow, nonmagnetic, inert

Nano gold is red, magnetic, explosive

Surface area is another major difference





Each side = 1 m (3.28 ft)
Weight roughly 43,000 lbs
Surface Area = 64.6 ft^2

Each side = 1 nm
Mass stays same, 43,000 lbs
Surface Area roughly 2,500 miles^2 (State of Delaware)

Let’s pause for discussion

- What strategies or techniques do you use to make technical information easier to understand?

List three applications of engineered nanomaterials in construction

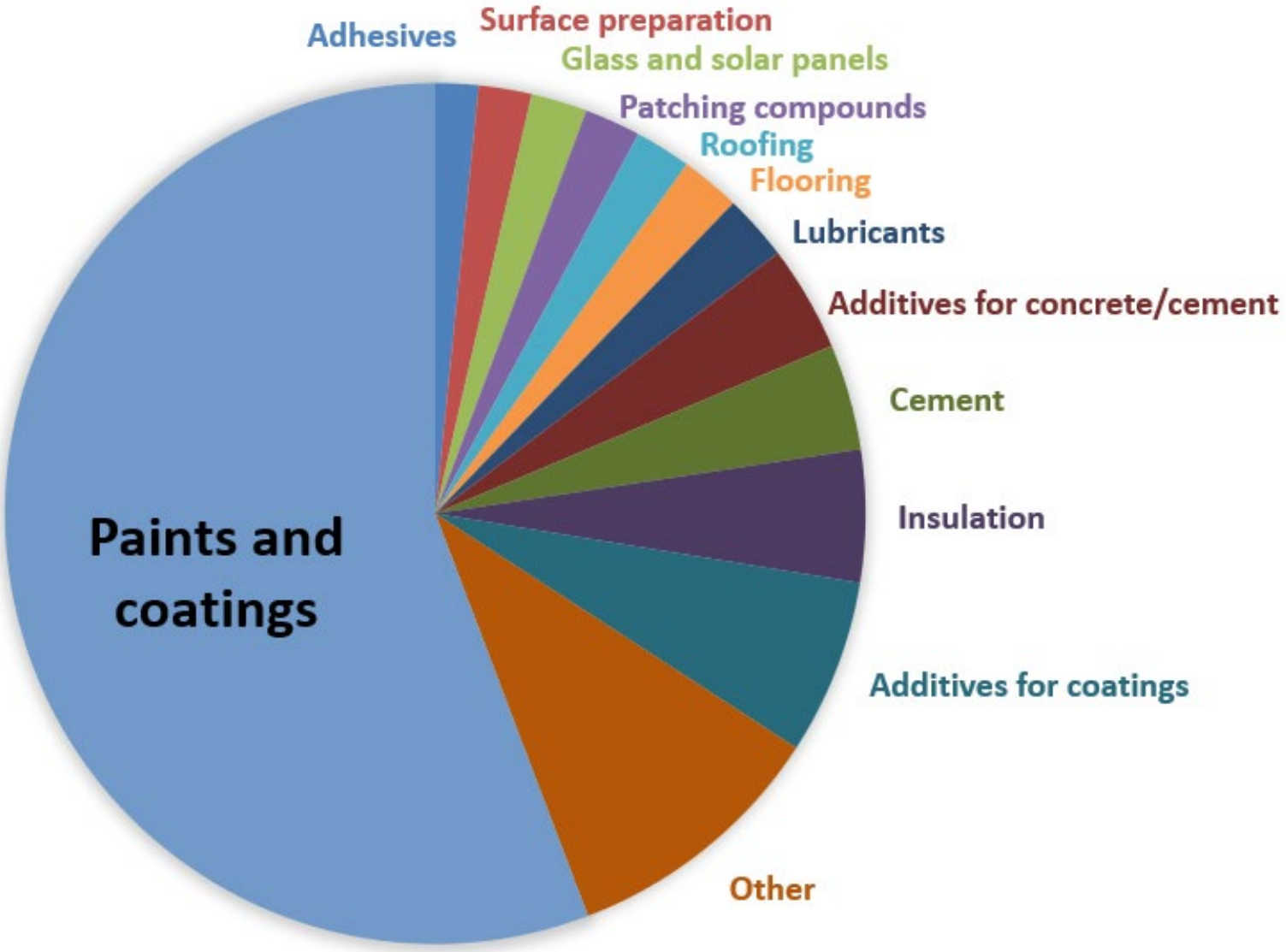
Objective 2

One prediction ten years ago was that by 2025, over 50% of building materials will contain nanomaterials

https://aecom.com/blog/for-future-cities-think-small-as-in-nano-2/

CPWR has documented "nano" claims for 873 construction products

www.nano.elcosh.org

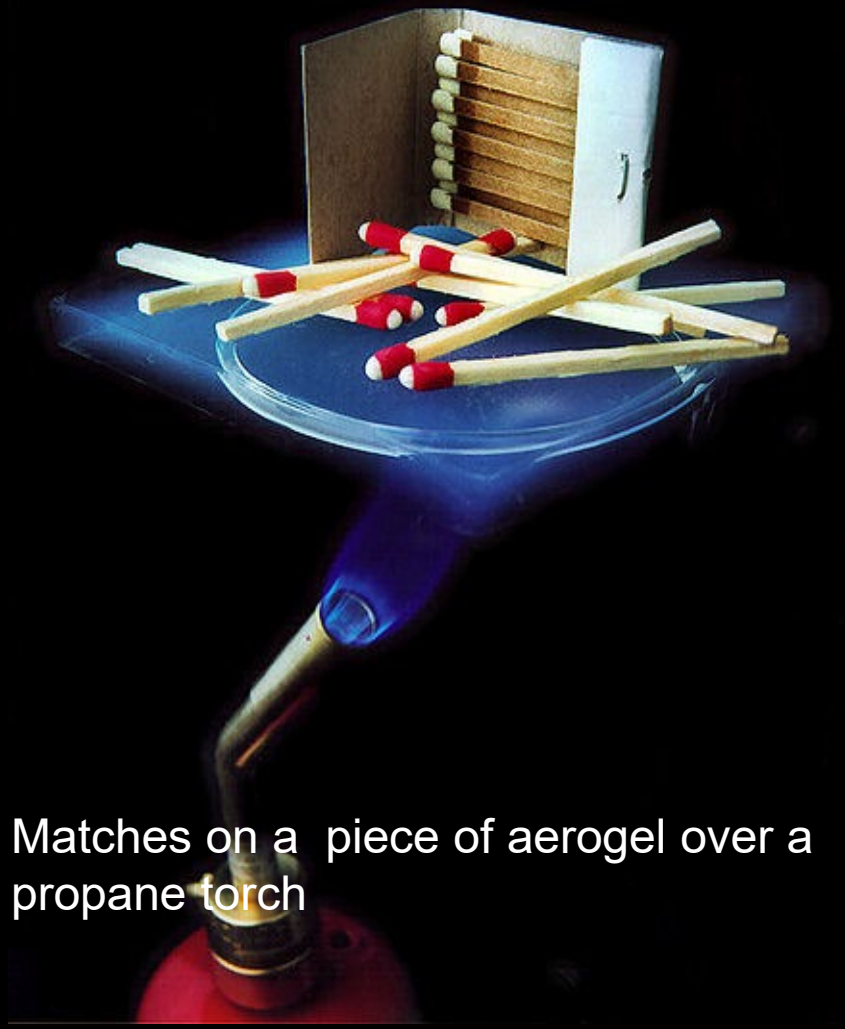


Paints and coatings dominate the inventory

The inventory helps to make the training trade-specific (e.g., painters)

- Anti-graffiti
- Anti-corrosive
- Anti-microbial
- Anti-pollution
- Densifying
- Self-cleaning
- Self-healing
- UV protective
- Water repellent
- Anti-corona virus

Case study: The insulators union worked with t ructured insulation material



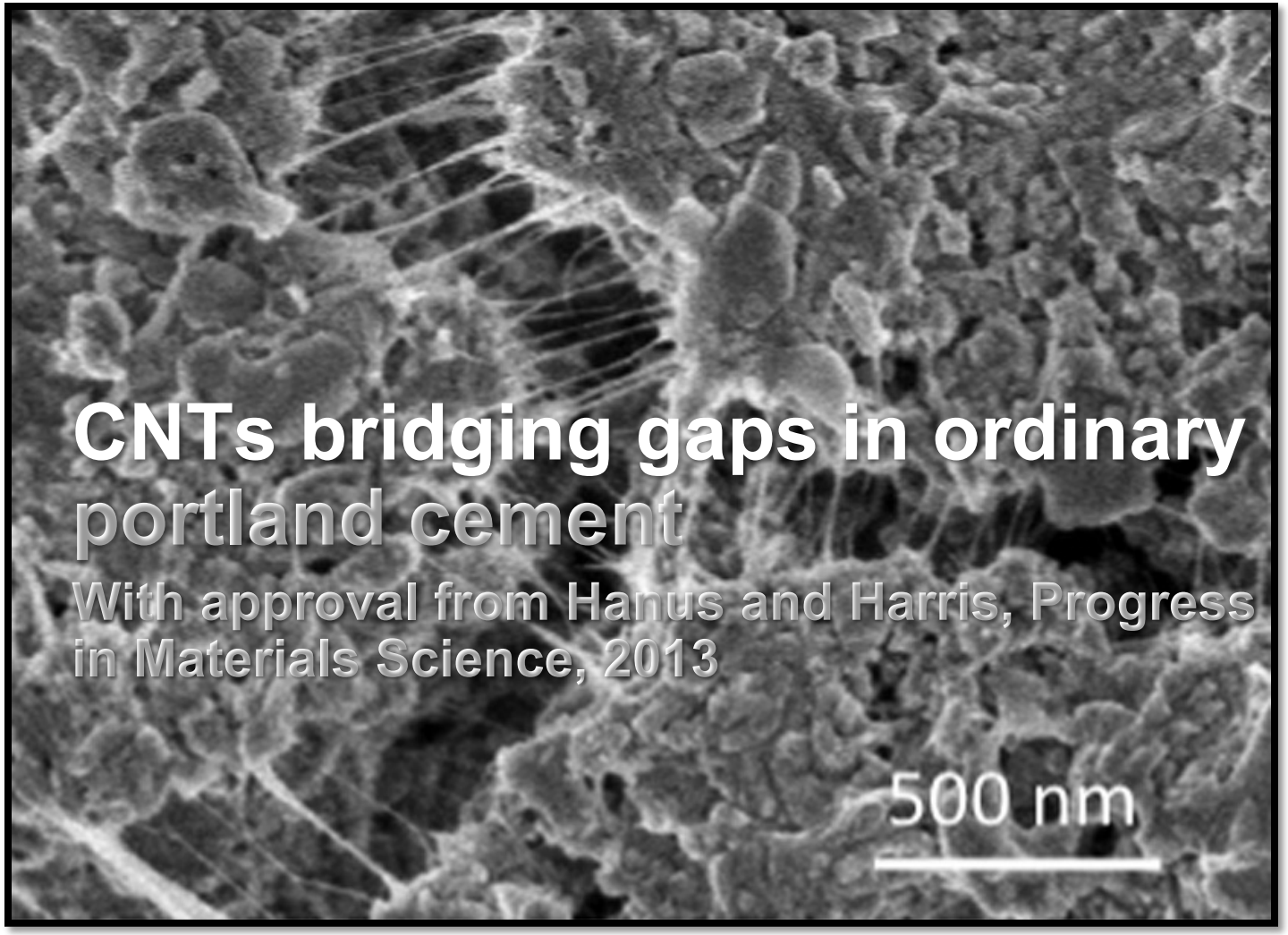
Matches on a piece of aerogel over a propane torch

A 2.5 kg brick supported by a piece of aerogel with a mass of 2 grams

Photos courtesy Wikimedia and NASA

...but members experienced dustiness, skin rashes and bloody noses. They asked NIOSH to help.

Carbon nanotubes can reinforce cement at 100X the tensile (stretching) strength of steel at a fraction of the weight



Carbon nanotubes are still being added to concrete roughly a decade after early testing began

In 2015, concrete road surface enriched with carbon nanotubes was tested on a portion of I-20 in GA and approved by GA DOT

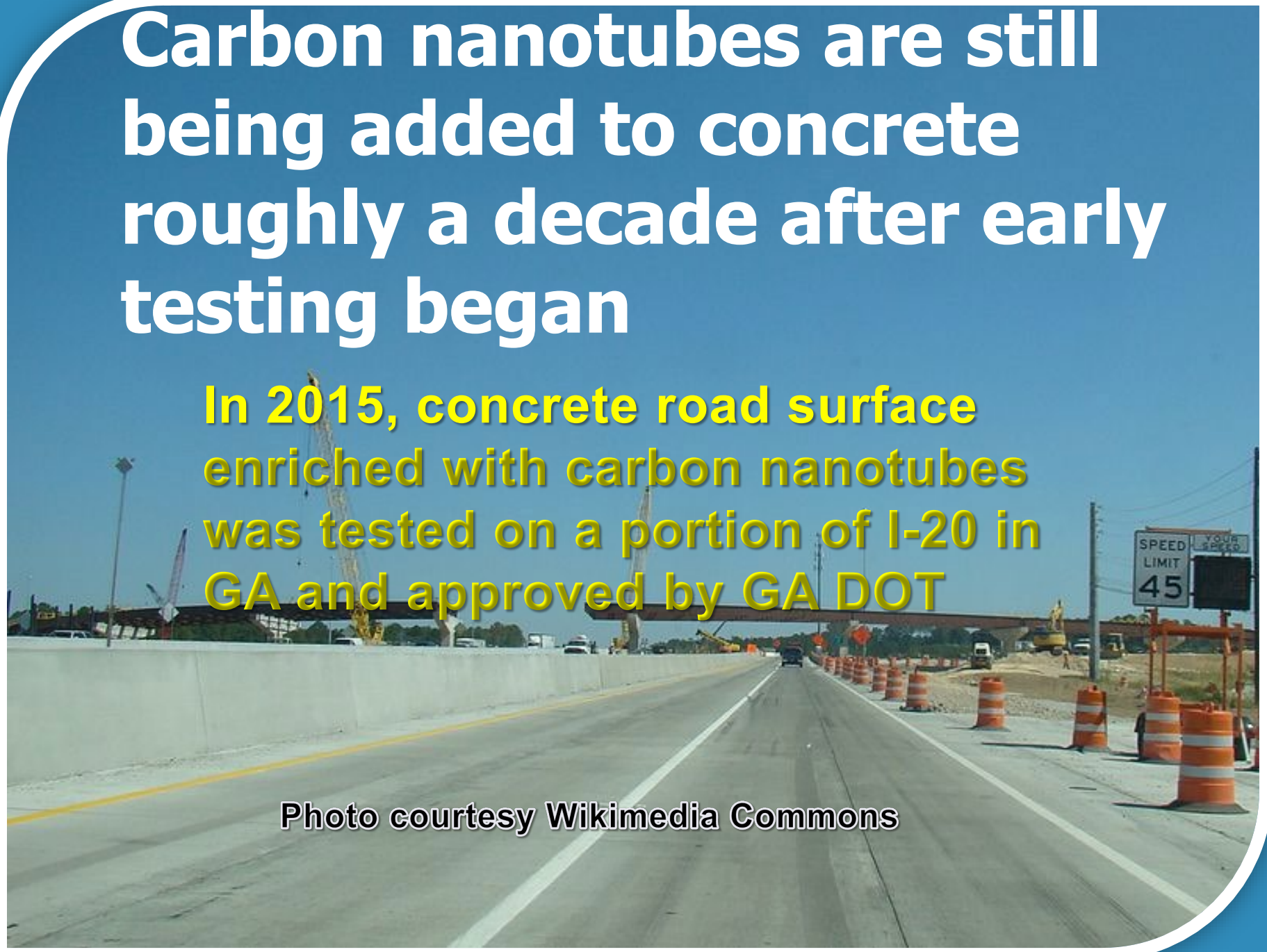
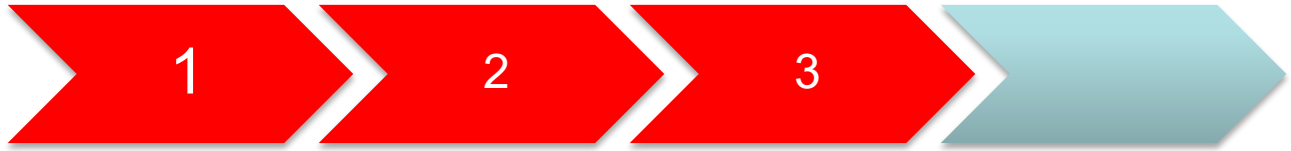


Photo courtesy Wikimedia Commons

Discuss what is known about engineered nanomaterial risks and exposure controls

Objective 3



Multi-walled carbon nanotubes have caused asbestos-like disease in lab animals (Suzui 2016; Takagi 2008; Poland 2008)

Multi-walled carbon nanotube penetrating the pleura of the lung. Courtesy of Robert Mercer, and Diane Schwegler- Berry, NIOSH

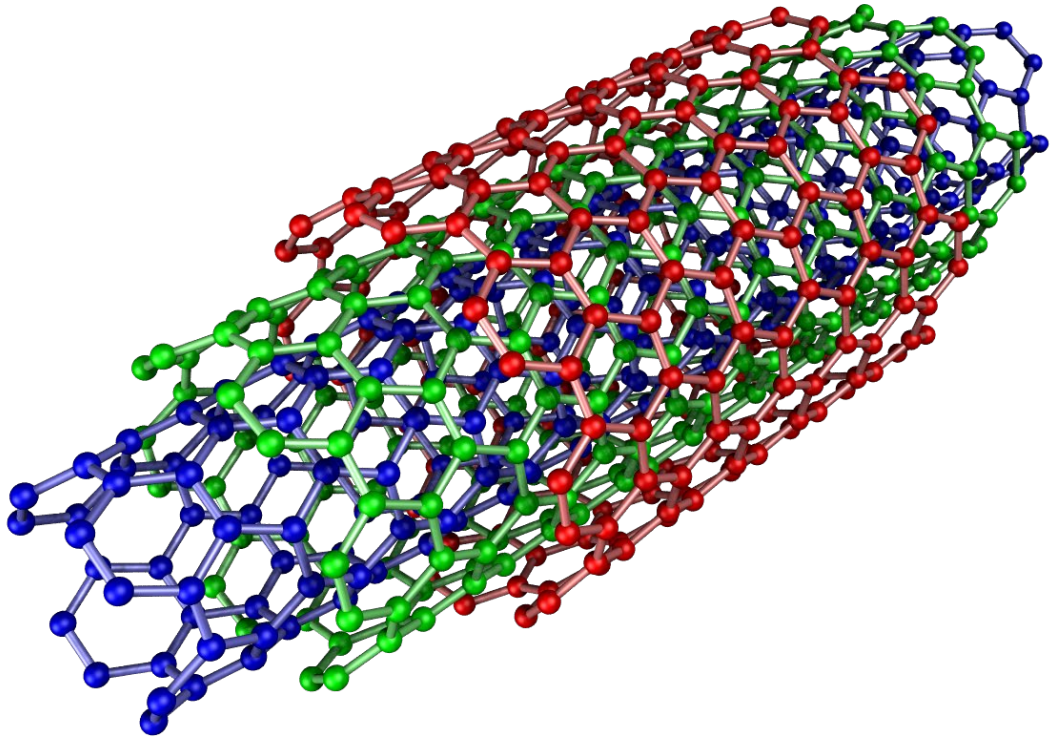


Diagram of multi-walled carbon nanotube
Courtesy of Eric Wieser and Wikimedia

Human health effects caused by ENM exposures remain largely unknown

But there is cause for concern based on:

- Air pollution research
- Laboratory tests in cells and animals


Image credit: Wikimedia/Gavin Schaefer

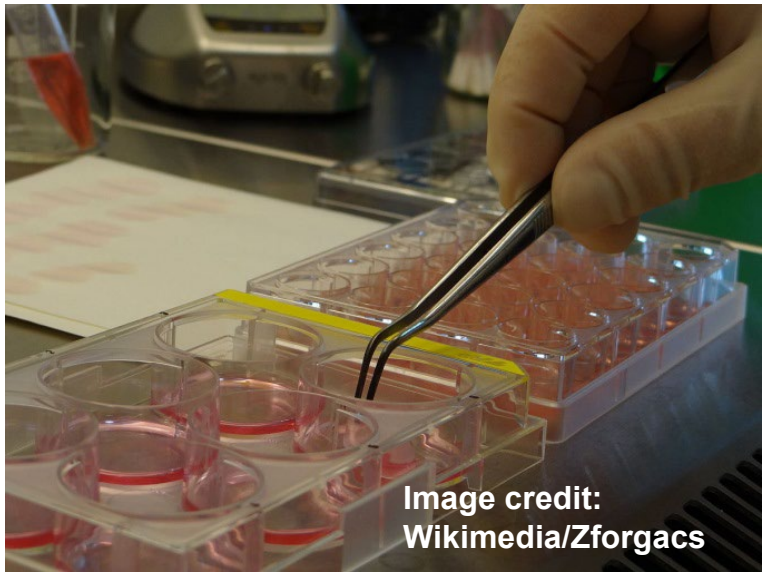


Image credit: Wikimedia/Zforgacs

A 2019 review of worker health effects concluded that

"In this state of uncertainty, **precautionary controls for each engineered nanomaterial are warranted** while further study of potential health effects continues."

Paul Schulte et al (2019)

Like other airborne hazards, inhalation is the main route of entry for nanoparticles

- Airborne NPs can be inhaled and deposited in the respiratory tract
- Inhaled NPs may enter the blood stream and move to other organs

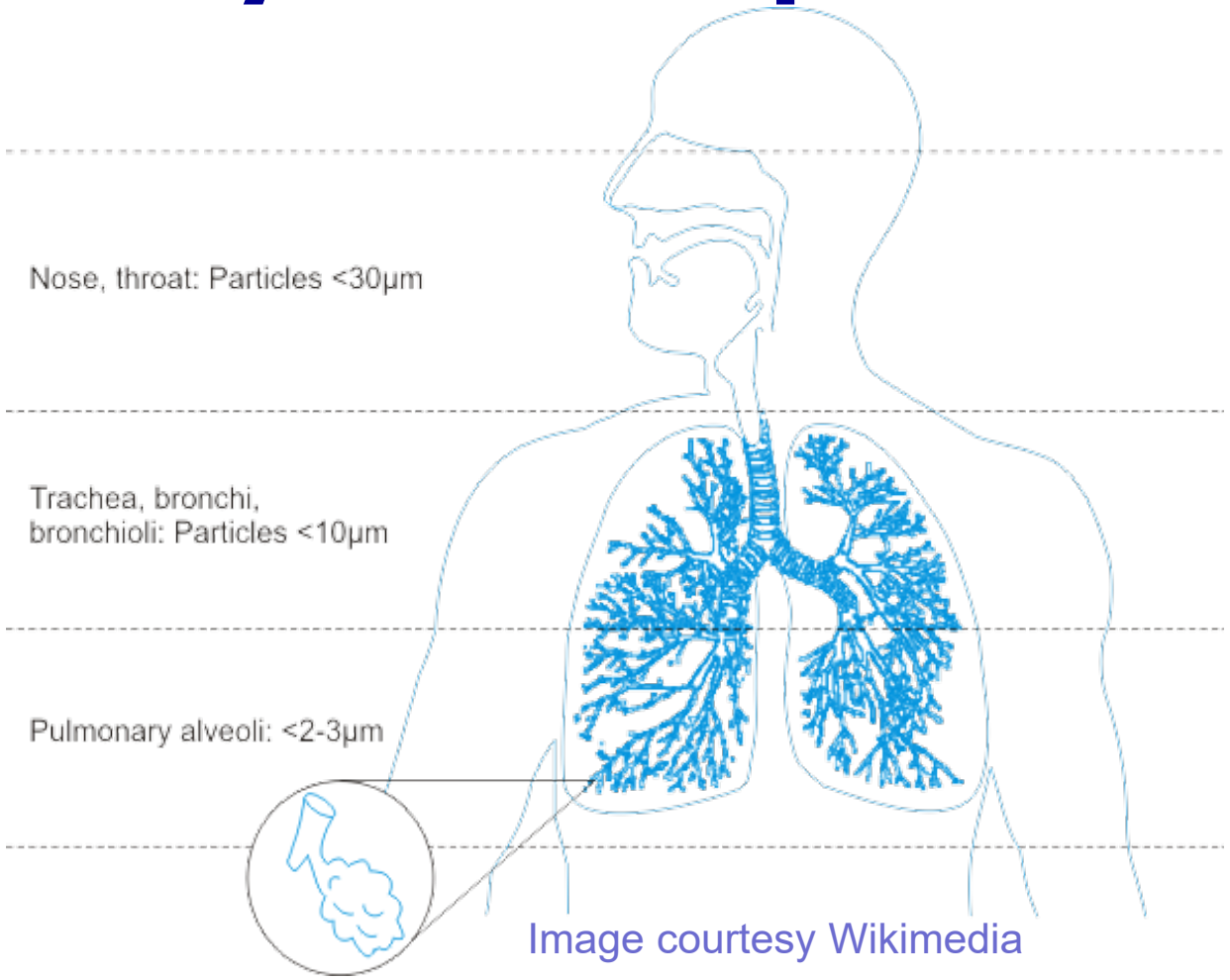


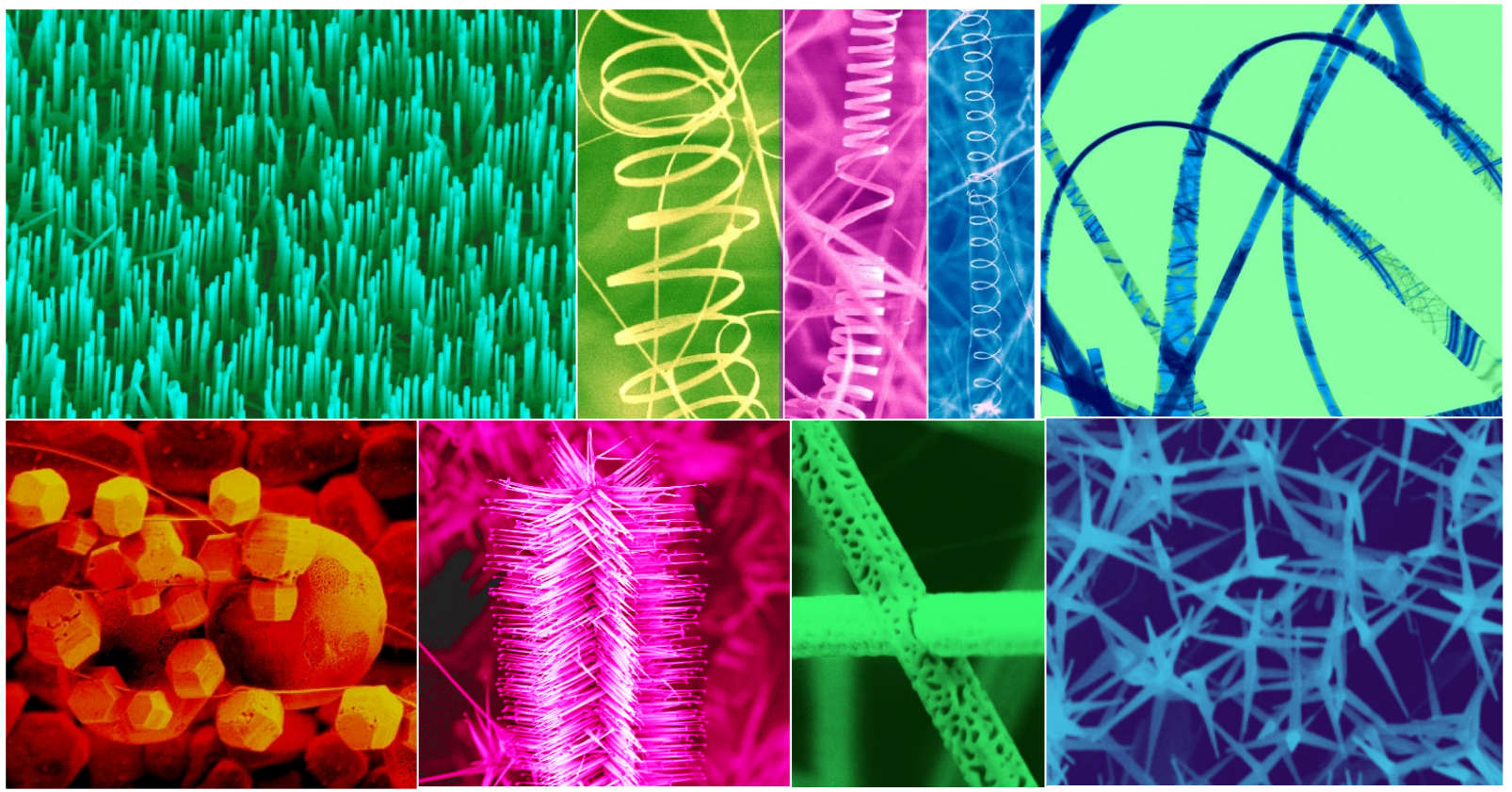
Image courtesy Wikimedia

Metal nanoparticles have been shown to penetrate flexed, damaged or diseased skin

Photo courtesy International Union of Operating Engineers

Photo courtesy J. Vinton Schafer & Sons, Inc. and CCBC

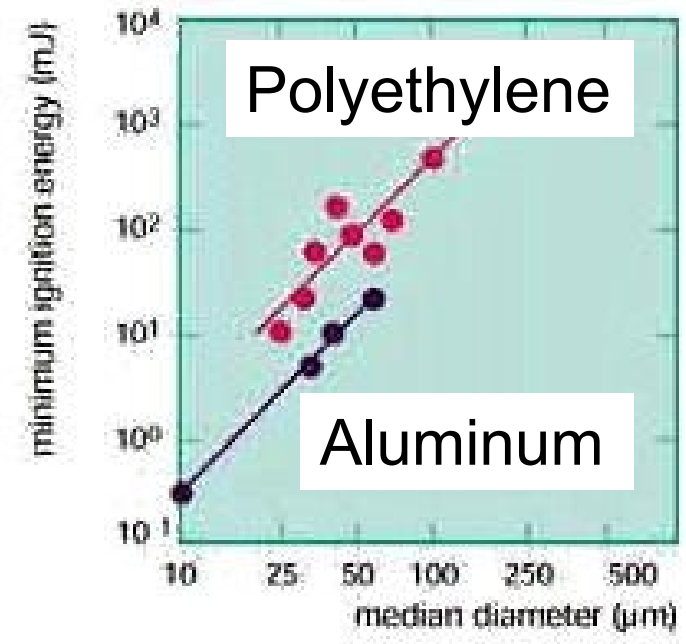
Remember this slide from earlier?



These are all nano zinc oxide

Image courtesy Dr. Zhong Wang, Georgia Tech

From a safety perspective, flammability and explosivity of nano-powders must be considered



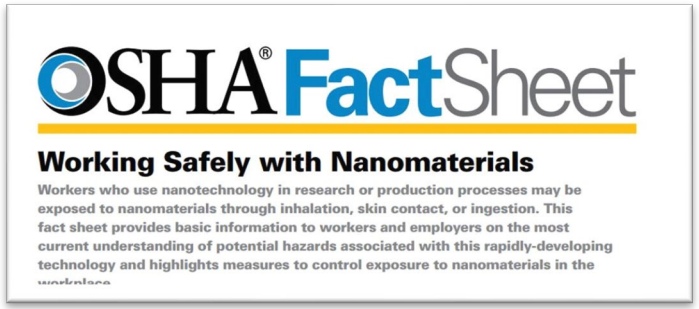
Netherlands Organization for Applied Scientific Research

Slide courtesy John Howard

NIOSH has Recommended Exposure Limits (RELs) for 3 nanomaterials

- Carbon Nanotubes and Nanofibers
- Titanium Dioxide
- Silver
- NO OSHA PELs for any nanomaterials!

However, official OSHA guidance recommends following all NIOSH RELs

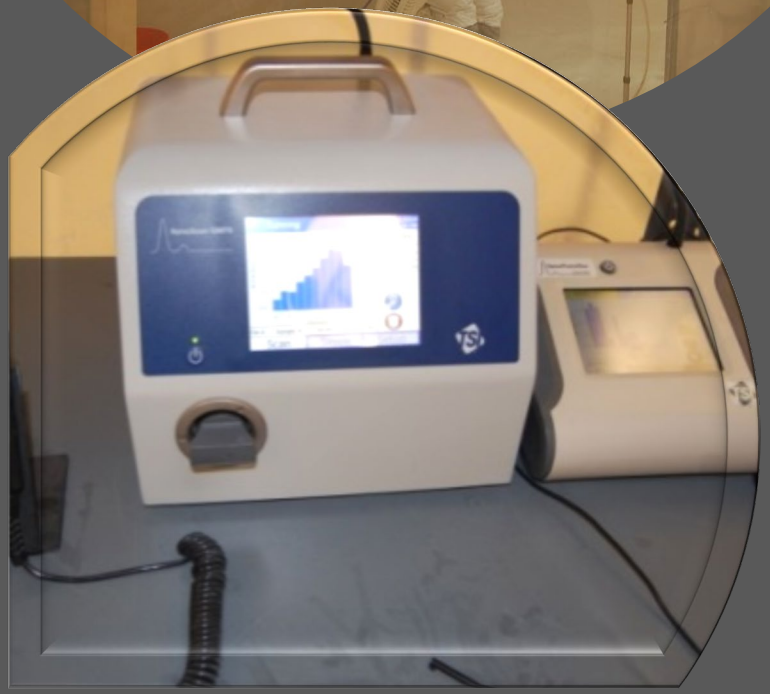

OSHA FactSheet

Working Safely with Nanomaterials

Workers who use nanotechnology in research or production processes may be exposed to nanomaterials through inhalation, skin contact, or ingestion. This fact sheet provides basic information to workers and employers on the most current understanding of potential hazards associated with this rapidly-developing technology and highlights measures to control exposure to nanomaterials in the workplace.

https://www.cdc.gov/niosh/topics/nanotech/pubs.html

https://www.osha.gov/sites/default/files/publications/OSHA_FS-3634.pdf

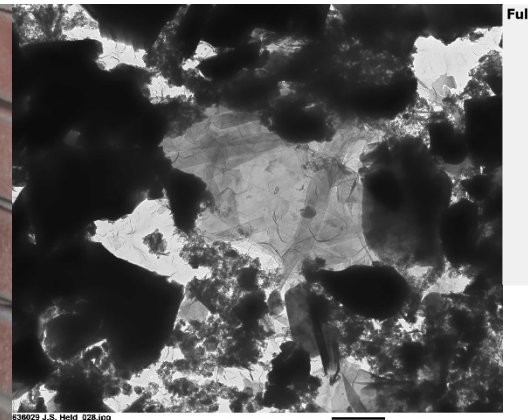


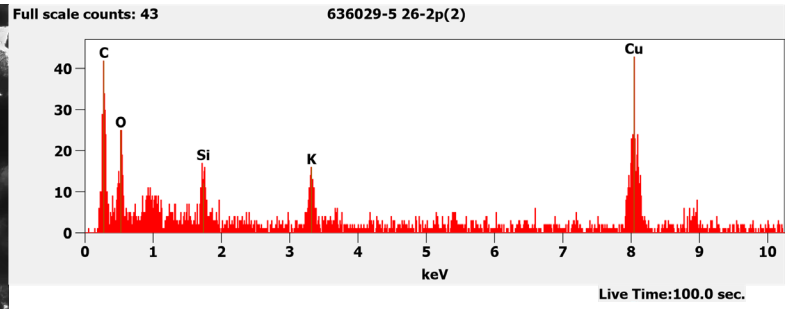
CPWR conducted multiple exposure studies involving paints, coatings, and cementitious materials

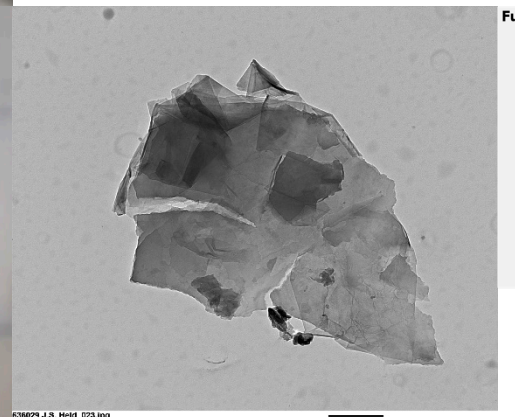
What have task-based exposure studies shown?

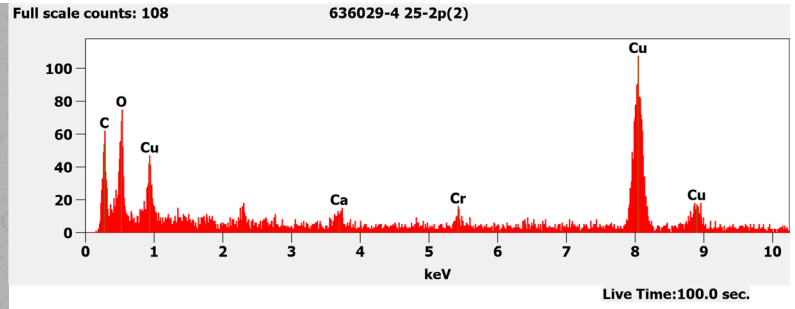
Spraying nano paints and coatings may **exceed** occupational exposure limits

High energy tasks appear to increase the likelihood of ENMs being released in higher quantities from composites









Our research shows that exposure controls used in construction are effective

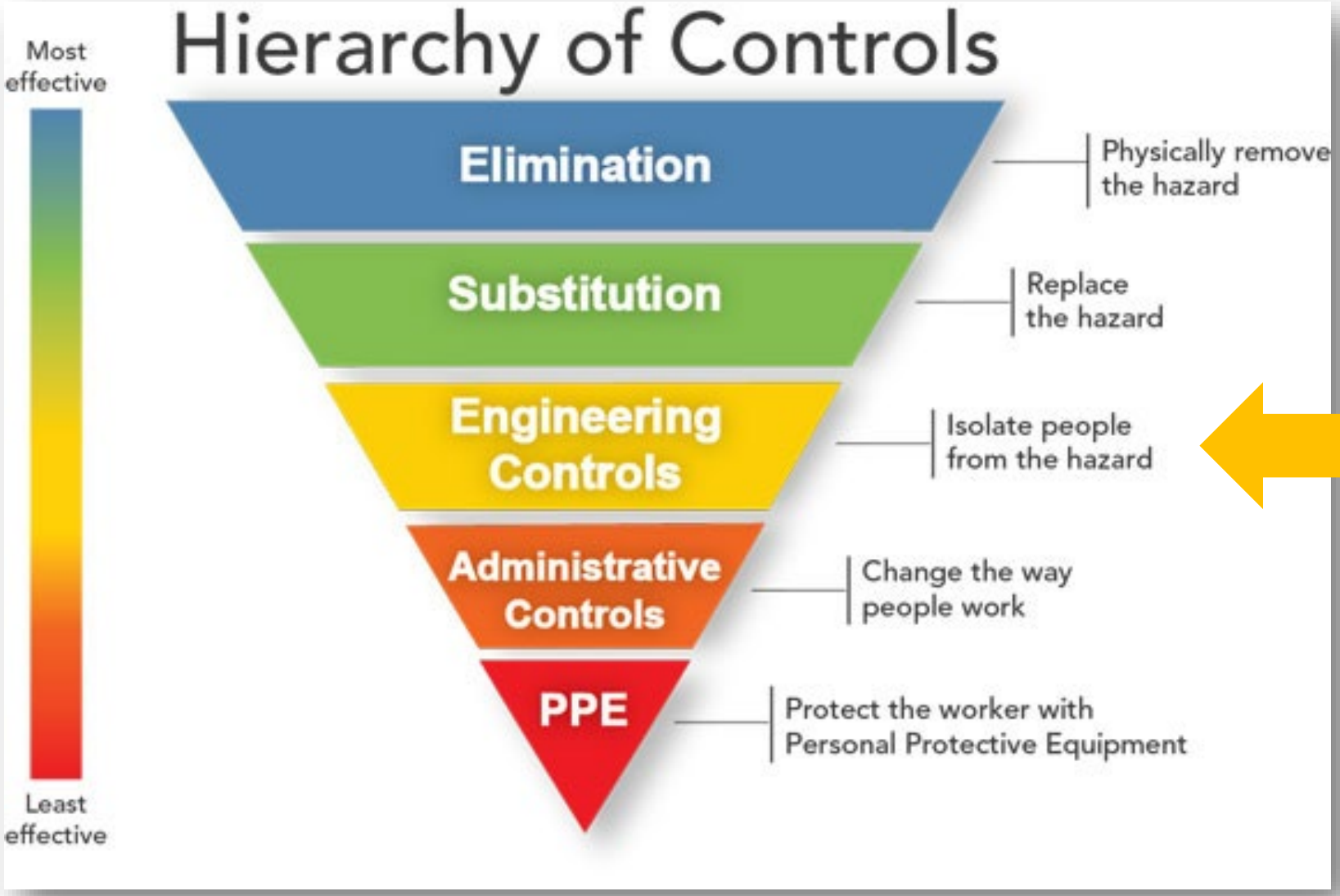


Photo courtesy Earl Dotter

Wet methods will work too!

Image credit:
Kiewit Power Constructors

Work practices can make a difference because of "bystander exposures"

Spraying nano coating on glass
Photo courtesy Broekhuizen

Photo courtesy Zenjiro and Wikimedia

PPE

Will respirators work against nanoparticles?

- Full-face

- Half-face

Elimination

Substitution

Containment

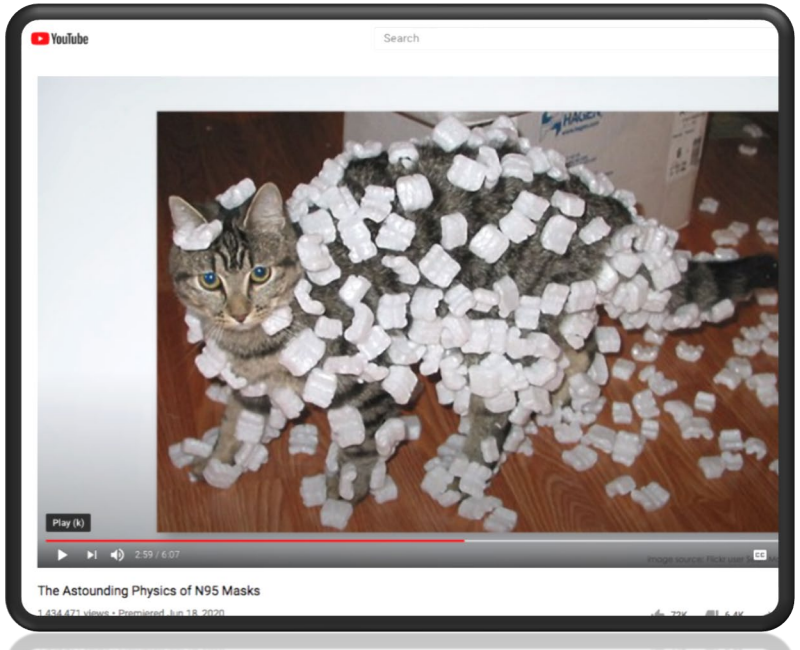
Ventilation

Work Practices

Personal Protection

Yes! HEPA filters capture nanoparticles

3M half-face air-purifying respirator with P100 particulate filter
and organic vapor (OV) cartridges



Great video on how filtration works!

https://www.youtube.com/watch?v=eAdanPfQdCA&feature=youtu.be&t=9

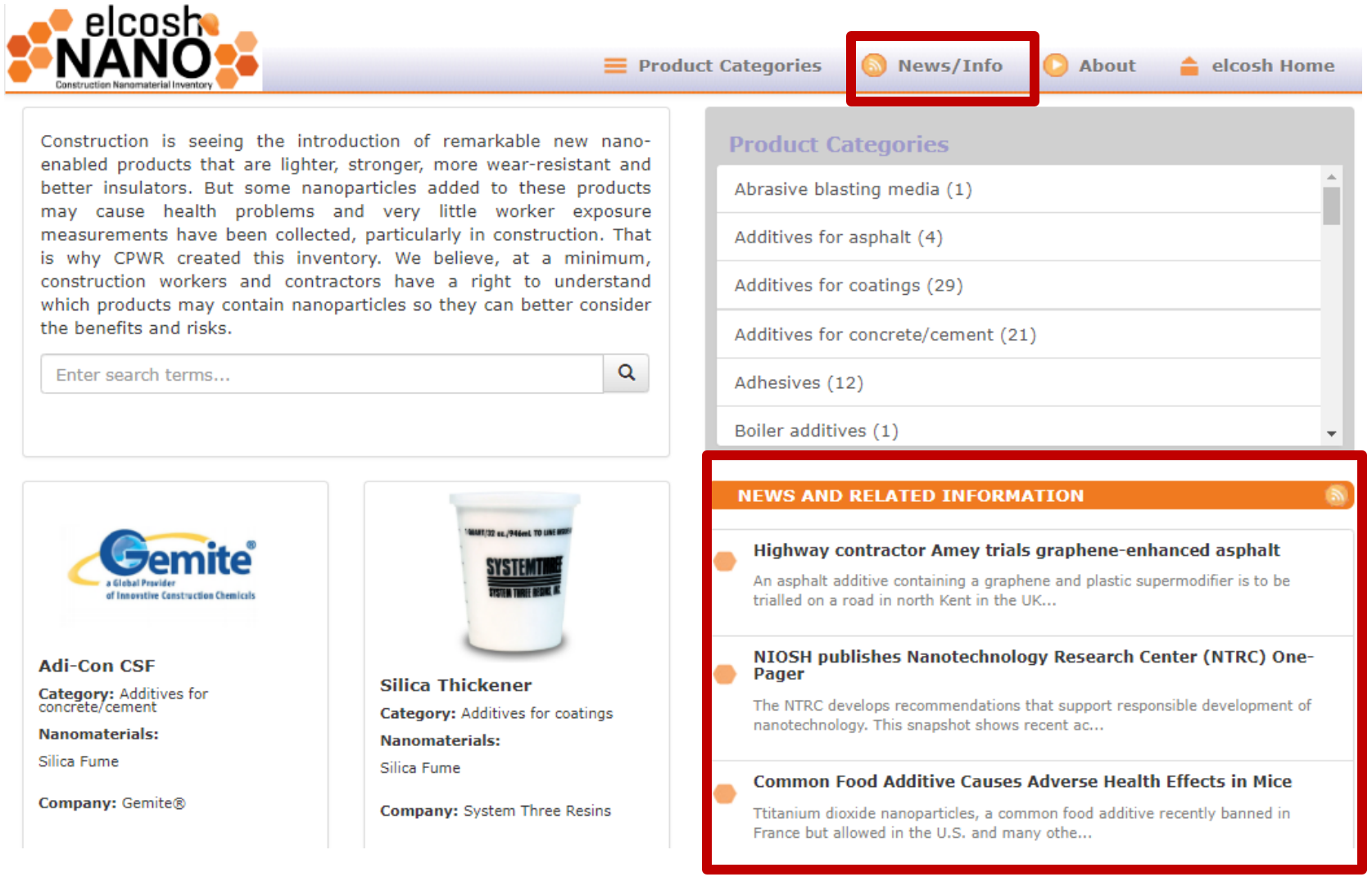
Images courtesy 3M Corp and Wikimedia

Use information about engineered nanomaterials in the courses you teach

Objective 4

1 2 3 4

The news & info section of elcosh nano has a collection of articles by topic



We continue adding to our collection of nano toolbox talks, which received over 10,000 downloads in one year

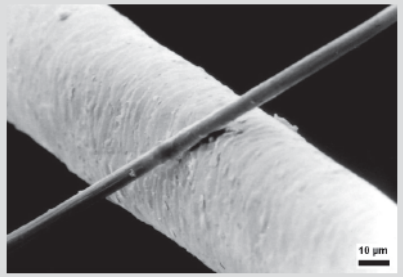
Photo courtesy: Morgan Zavertnik and Hoar Construction

https://www.cpwr.com/research/research-to-practice-r2p/r2p-library/toolbox-talks/

What are Nanomaterials?

There are many kinds of nanomaterials, but they all share a remarkably small size (roughly 100,000 times thinner than a human hair). At this size, they can add new properties to many construction products.

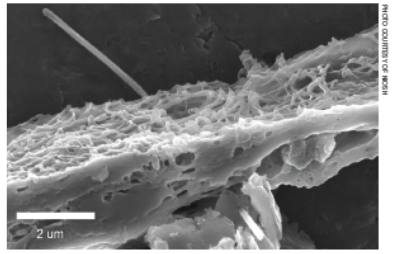
Nanoparticles exist in nature and in man-made combustion sources, but this alert is about manufactured nanomaterials that are added to products. These products are called nano-enabled.



A carbon nanotube laying across a human hair

What are the risks?

Some nanomaterials may be safe, but others have been shown to be toxic in the lab. Of particular concern are respiratory exposures to long, thin fibers, such as carbon nanotubes (CNTs). Certain types of CNTs cause lung problems in rodents, similar to asbestos. Nanoparticles don't seem to penetrate healthy skin but may get through damaged skin. Nanomaterials can be released from nano-enabled products, but the risks are not well understood. **The key is to limit exposure.**



Multi-walled carbon nanotube penetrating the lung

PROTECT YOURSELF

1 Learn about nanomaterials in your trade

CPWR maintains a website called **eLCOSH Nano** that features over 450 products that may be nano-enabled.

elcosh NANO
Construction Nanomaterial Inventory
www.nano.elcosh.org

Construction products that may contain nanomaterials include:

- **Coatings**
- **Lubricants**
- **Cements**
- **Adhesives**
- **Insulation**
- **Patching compounds**

2 Control dust

NIOSH and CPWR have demonstrated that dust collection systems attached to tools will reduce the number of nanoparticles along with normal dust. Wet methods will work, too.

Worker with full protective gear conducting CPWR test inside a special chamber using a dust collection system

3 Wear a respirator

Testing shows that nanoparticles do **NOT** get through high efficiency respirator filters. Reduce dust first with a dust collection system or water. If dust levels are still high, use a respirator.

Are nanomaterials regulated?

OSHA does not have a regulation or Permissible Exposure Limit for any specific nanomaterial, but there are many existing OSHA standards, like the respirator standard, that would still apply.

NIOSH has set Recommended Exposure Limits for carbon nanotubes and nano-sized titanium dioxide that employers should follow. EPA has reporting requirements for nanoparticles under TSCA.

Learn more

- OSHA Respiratory Protection Standard (29 CFR 1926.103): http://tinyurl.com/OSHA1926-103
- OSHA Nanotechnology: http://tinyurl.com/OSHAnano
- NIOSH Nanotechnology: http://tinyurl.com/NIOSHnano
- EPA TSCA Regulations for Nanoscale Materials: http://tinyurl.com/EPAnanoTSCA

If you think you are in danger:

Contact your supervisor.
Contact your union.
Call OSHA
1-800-321-6742

Find out more about construction hazards.

To receive copies of this Hazard Alert and cards on other topics
call 301-578-8500

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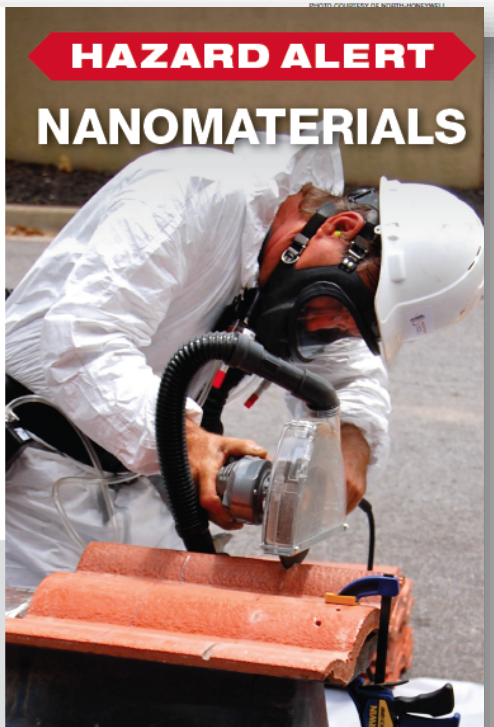
COVER PHOTO: Air sampling during cutting of photocatalytic roofing tiles

HAZARD ALERT

NANOMATERIALS



It's available on CPWR's main website (also in Spanish)

http://www.cpwr.com

ADVERTENCIA DE PELIGRO

CPWR

NANOMATERIALES

¿Qué son Nanomateriales?

Hay muchos tipos de nanomateriales, pero todos comparten un tamaño muy pequeño (aproximadamente 100,000 veces más delgados que un pelo humano). Con este tamaño, se pueden añadir nuevas propiedades a muchos productos de construcción.

Las nanopartículas existen en la naturaleza y en las fuentes de combustión hechas por el hombre, pero esta alerta es sobre nanomateriales manufacturados que se agregan a los productos. Estos productos se llaman nano-habilitados.

Un nanotubo de carbono pone a través de un pelo humano

¿Cuáles son los riesgos?

Algunos nanomateriales pueden ser seguros, pero otros se han demostrado ser tóxicos en el laboratorio. De preocupación particular es la exposición respiratoria a fibras largas y finas, como los nanotubos de carbono (CNT). Ciertos tipos de nanotubos de carbono causan problemas pulmonares en los ratones, similares al asbesto. Las nanopartículas no parecen penetrar la piel sana, pero pueden pasar a través de la piel dañada. Los nanomateriales pueden ser liberados de productos nano-habilitados, pero los riesgos no se conocen bien. **La clave es limitar la exposición.**

Nanotubos de carbono de pared múltiple penetrando el pulmón

Infórmese más sobre los peligros en la construcción.

Para recibir copias de esta Advertencia de Peligro y las cartas sobre otros temas

Llame al 301-578-8500

¡Protéjase!

1 Aprenda sobre los nanomateriales en su comercio

CPWR mantiene un sitio web llamado **eLCOSH Nano** que cuenta con más de 450 productos que pueden ser nano-habilitados.

elcosh NANO

www.nano.elcosh.org

Los productos de construcción que pueden contener nanomateriales incluyen:

- Recubrimientos
- Cementos
- Aislamiento
- Lubricantes
- Adhesivos
- Compuestos de Parche

2 Controle el Polvo

NIOSH y CPWR han demostrado que los sistemas de recolección de polvo conectados a herramientas reducirán el número de nanopartículas junto con el polvo normal. Métodos húmedos también son efectivos.

Foto: Trabajador con el equipo de protección completo realizando pruebas para CPWR dentro de una cámara especial utilizando un sistema de recolección de polvo

3 Use un respirador

Las pruebas han mostrado que los nanopartículas **NO** pasan por respiradores con filtros de alta eficiencia. Primero reduzca el polvo con un sistema de recolección de polvo o agua. Si los niveles de polvo siguen siendo altos, use un respirador.

¿Se regulan los nanomateriales?

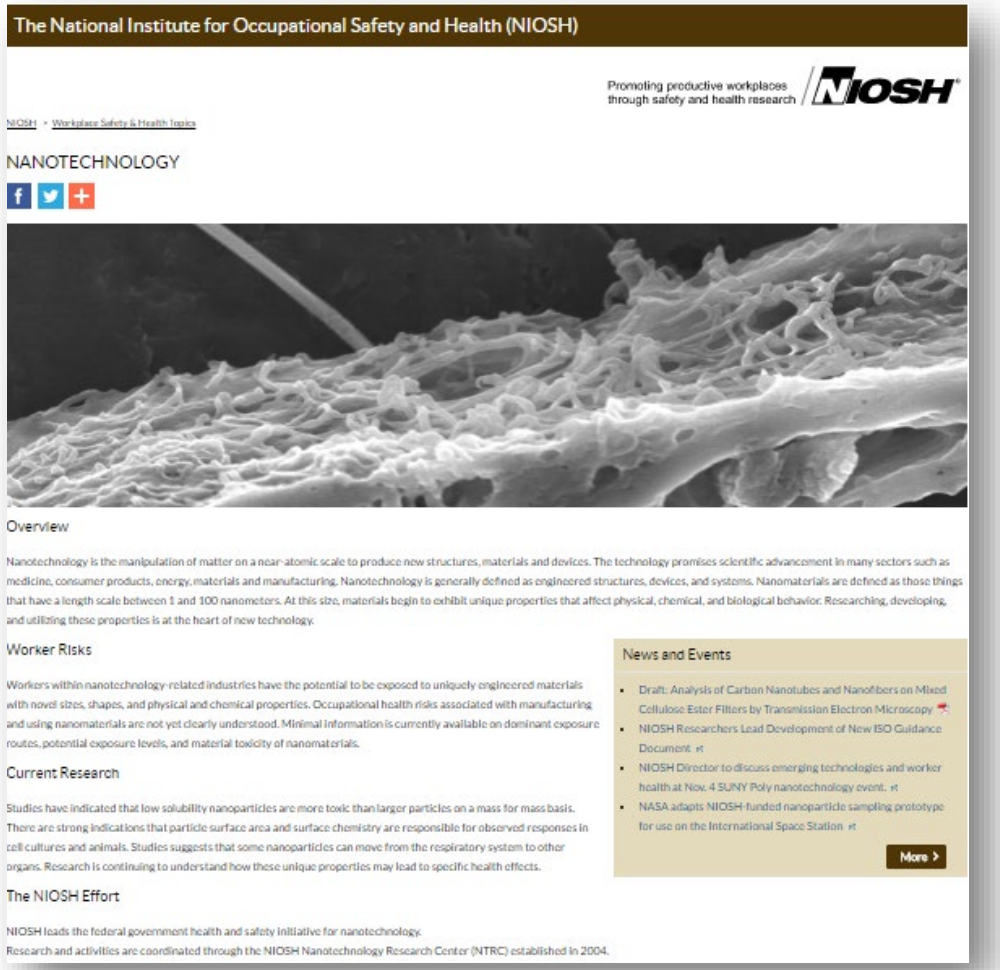
OSHA no tiene una norma o Límite de Exposición Permisible para algun específico nanomaterial, pero hay muchas normas de OSHA existentes, como la norma de respiradores, que aun aplicarían. NIOSH ha establecido los Límites de Exposición Recomendados para nanotubos de carbono y dióxido de titanio de tamaño nanométrico que los empleadores deben seguir. La EPA tiene requisitos para el reportaje de nanopartículas bajo TSCA.

Aprende más

- OSHA Norma de Protección Respiratoria (29 CFR 1926.103): http://tinyurl.com/OSHA1926-103

NIOSH's nanotechnology website has useful information on exposures and controls

https://www.cdc.gov/niosh/topics/nanotech/default.html



- Recommendations
- Guidance
- News

Group discussion

- Have you conducted training on emerging issues or topics that are not fully understood?
- If so, what challenges did you face and how did you try to overcome them?
- What strategies do you find effective in communicating risks to workers?

- Any other comments or questions?

Thank you!

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