Training Workers about Nanomaterials

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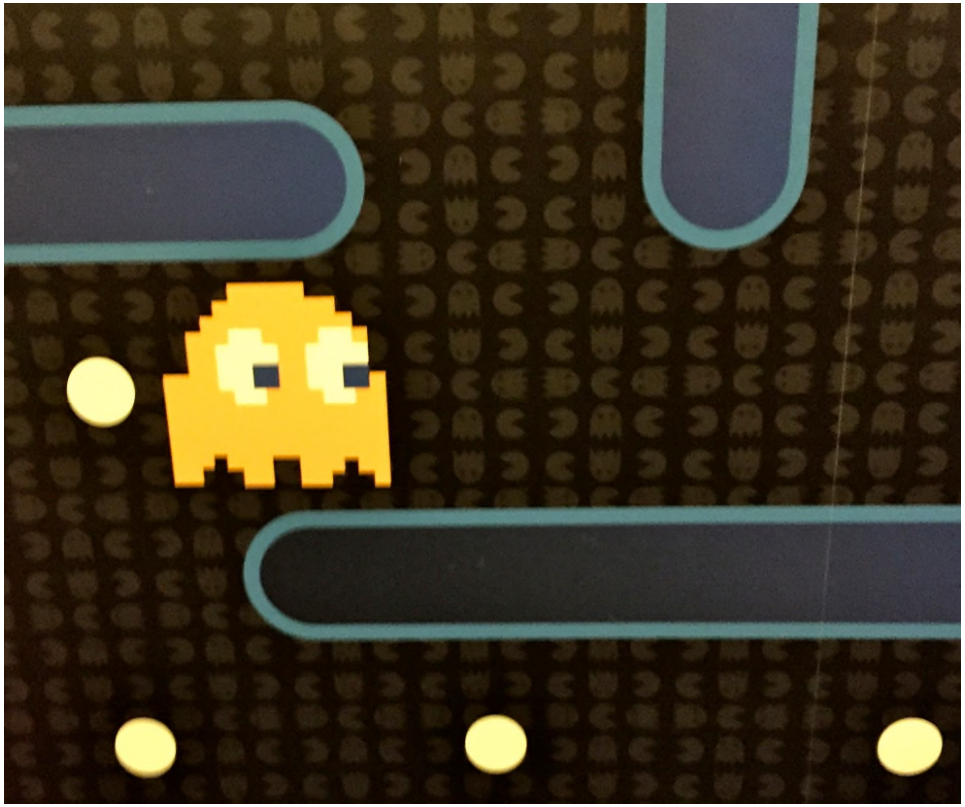
CPWR

THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

Introductory Comments



Electron micrograph of a metal oxide nanoparticle

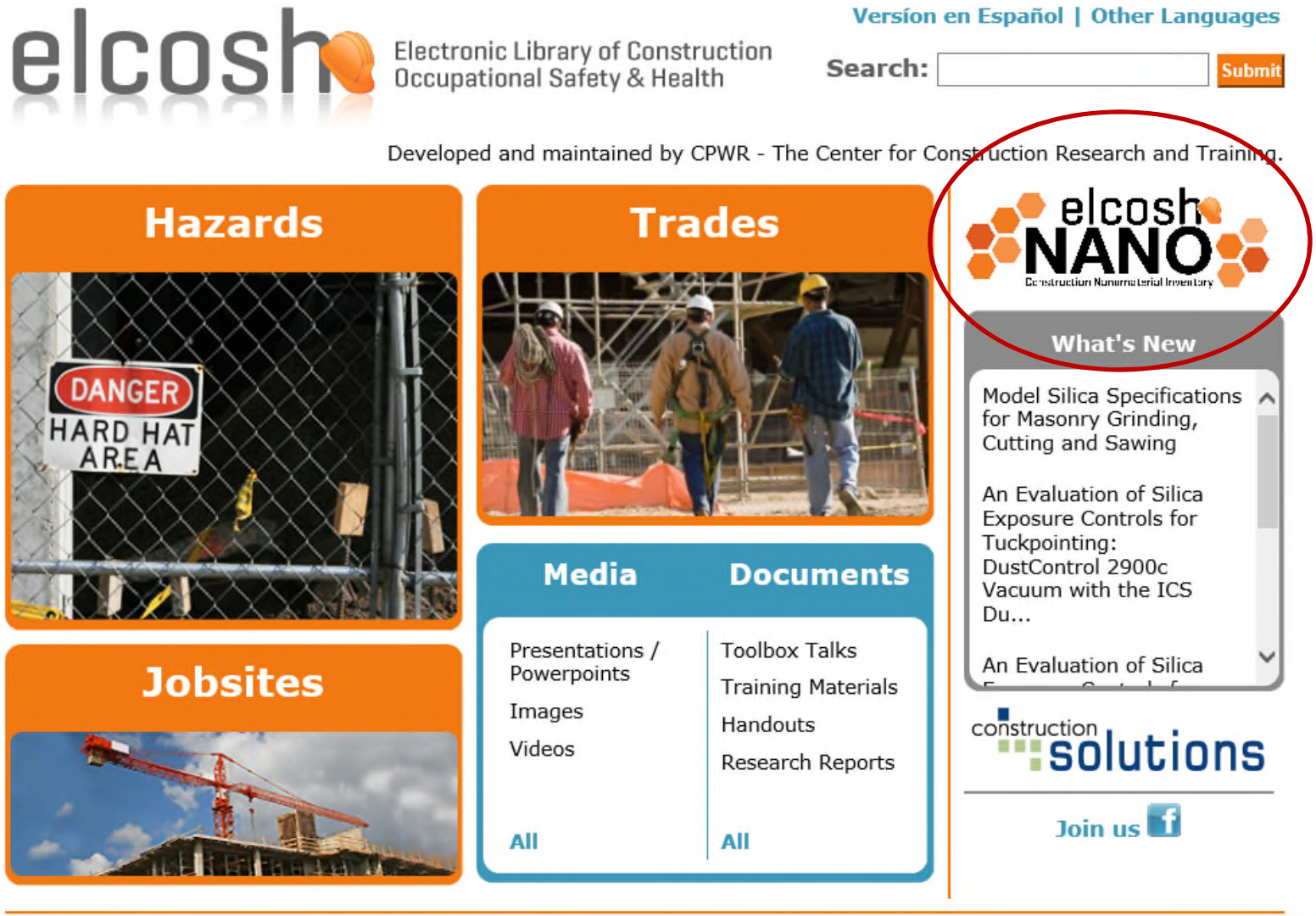
Background on the speaker

Early warning of interest in Industrial Hygiene

CPWR is a U.S. nonprofit funded by NIOSH and NIEHS

My comments are my own and not those of NIOSH or NIEHS

Who has used eLCOSH.org?

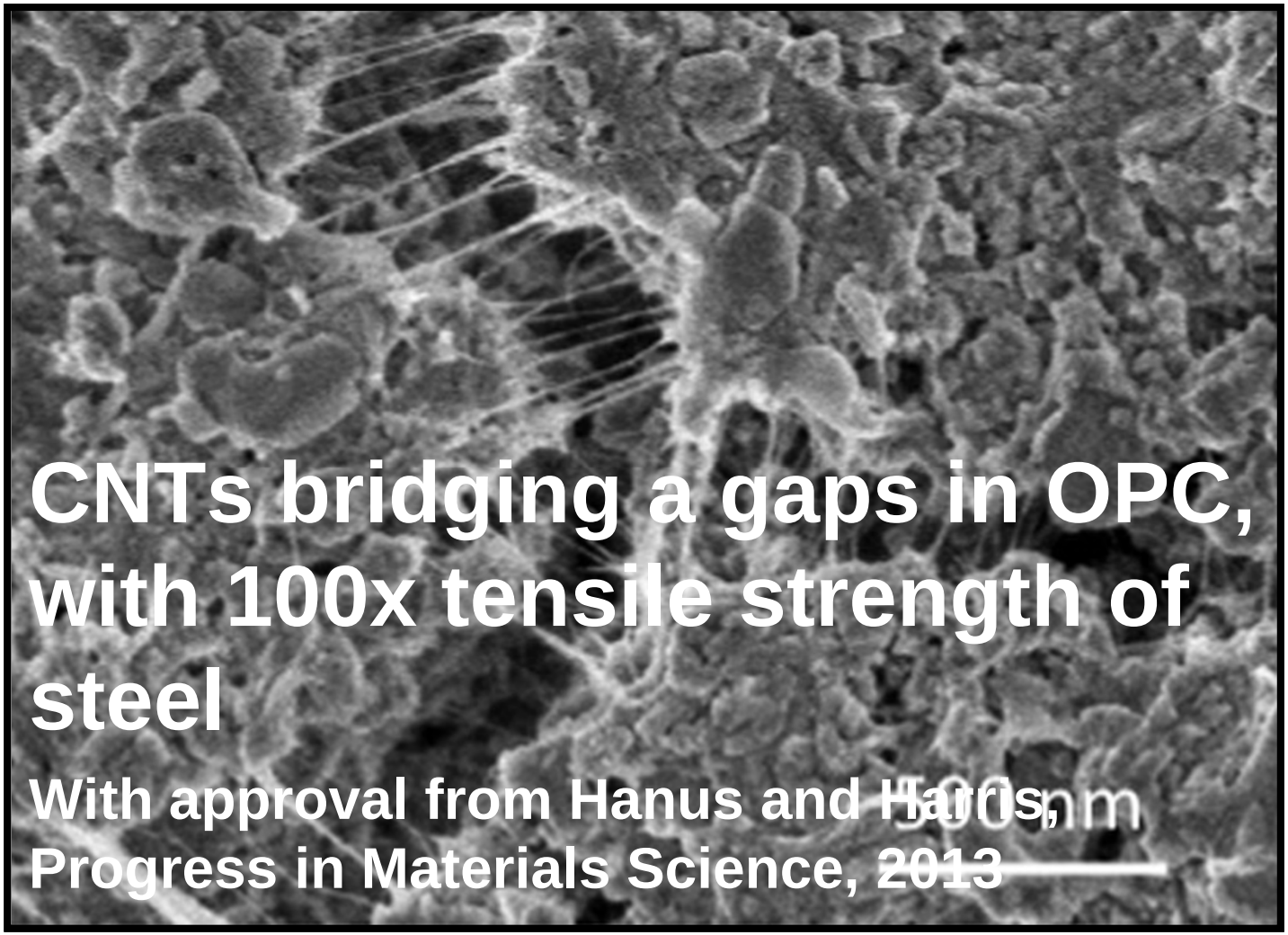


When we think of nanomaterials, we see this:

Center for Nanophase Materials Science, Oak Ridge, TN

But not construction!

Nanomaterials are bringing major changes to construction



No epi studies, but mesotheliomas have been produced in mice with MWCNTs (Takagi 08, Poland 08)

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

Here's the questions we'll tackle:

1. What do we know about use of nanomaterials in construction?
2. What is the state of hazard communication around nanomaterials?
3. How informed are workers?
4. How should workers be trained about nanomaterials?

What do we know about the use of nanomaterials in construction?

Question 1

Does any organization know how many nano-enabled products are in commerce?

Construction workers apply greater energy to nanomaterials

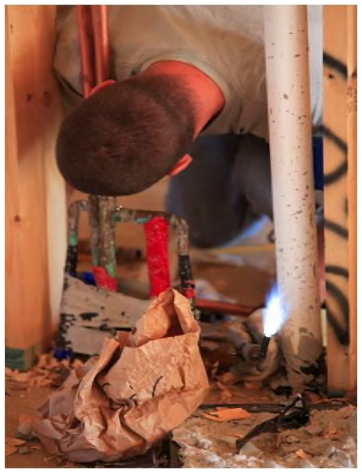
Construction exposures may be greater when the life cycle is considered

Production

Installation

Maintenance

Recycling/
Demolition/



What happens with Hazcom?

TiO_2 self-cleaning windows can reduce worker fall exposures

March 16, 2015

outside my office!

One prediction is by 2025, over 50% of building materials will contain nanomaterials

That is a long way from where we are now!

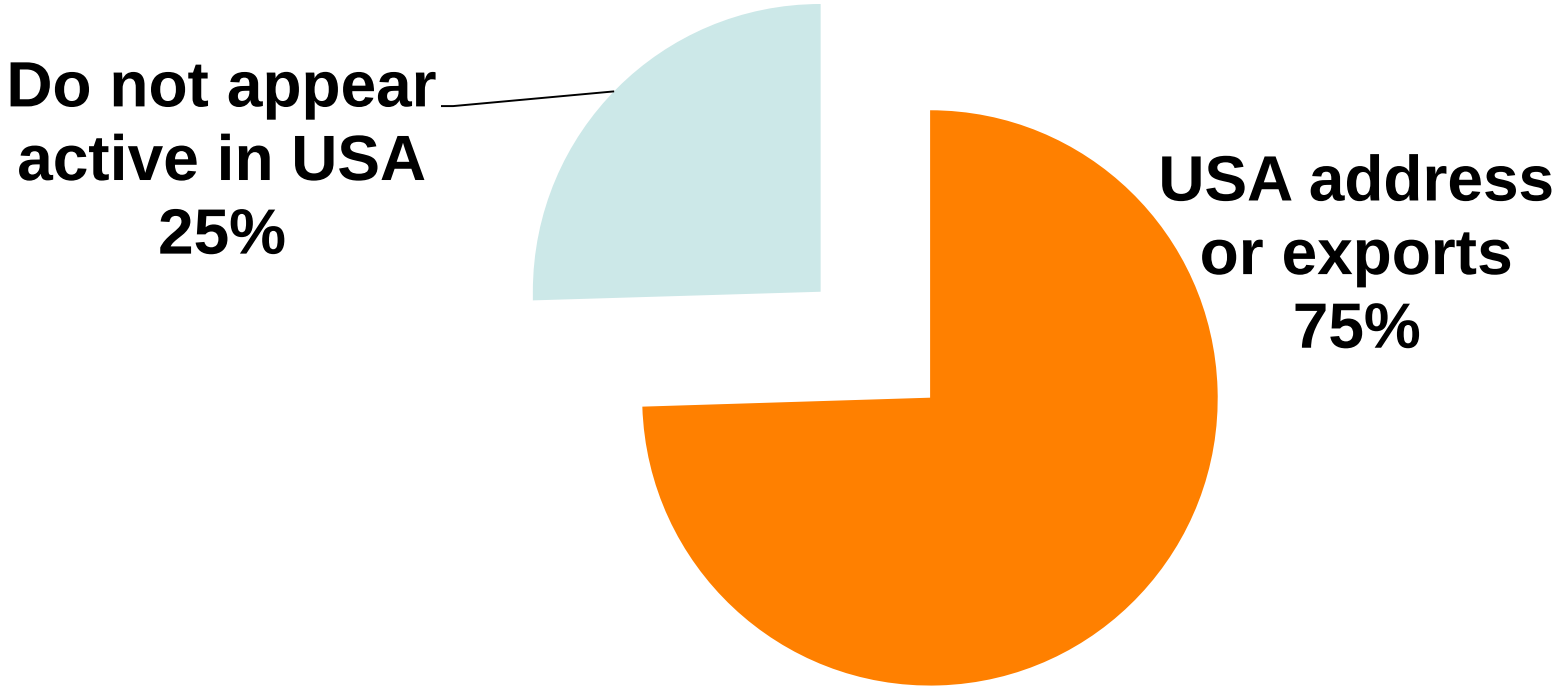
Courtesy Dr. Wendy Jones

Loughborough University

Our site currently features 545 commercial construction products reported to be nano-enabled

www.nano.elcosh.org

Three-quarters provide a U.S. address or export to U.S.



Roughly 40% did not specify the composition

Unspecified composition	178	38.9%
nanofibers	1	0.2
nanomaterials	15	3.3
nanoparticles	76	16.6
Nanotechnology	70	15.3
nanotubes	1	0.2
photocatalytic materials	5	1.1
reference to 'nano'	10	2.2

Safety Data Sheets could not be confirmed for 55% of products

What is the current state of hazard communication for nano?

Question 2

1 2

Using an car analogy, it would be a Yugo in this exact color

Photo courtesy Wikimedia Commons

A 2008 review of the literature showed significant problems

Nicol et al. 2008, Am. J. Ind Medicine

"While MSDSs are still considered to be a **mainstay of worker health and safety**…there are significant problems with their accuracy and completeness. As such, **they may be failing workers** as a prevention tool."

MSDSs were indicated as the preferred method of obtaining EHS info by nanotech firms

Lindberg and Quinn, 2007

A Survey of EHS risk management among nanotechnology firm in the Massachusetts Region

The new NIOSH REL for carbon nanotubes is 1 µg/m³

Section 1 Product Identification

Chemical Name:	Carbon Fullerene
Formula:	Carbon
Chemical Family:	Synthetic Graphite
Synonyms:	Carbon Nanotubes
CAS Number:	7782-42-5 (Graphite)

"Nuisance" dust standard for synthetic graphite:

15 mg/m³ total

5 mg/m³ resp

Section 2 Composition and Information on Ingredients

Component	%	OSHA/PEL	ACGIH/TLV
Synthetic graphite	Up to 100%	15 mg/m³ (total dust) 5 mg/m³ (respirable fraction)	2 mg/m³ TWA

Workers may be at risk of lung lesions exposed to SWCNTs 20 days at 5 mg/m^3

Shvedova et al., Am. J. Physiol. Lung Cell Mol. Physiol. 2005

NewLook International, Inc. Graf-X WB™

Material Safety Data Sheet **SDS**

Section 1
PRODUCT & COMPANY IDENTIFICATION

Product Names: Graf-X WB™ Permanent Anti-Graffiti Coating
Manufacturer's Name: NewLook International, Inc.
Manufacturer's Address: 1525 South Gladiola Street, Suite 8, Salt Lake City, UT 84104
Information Phone: NewLook International, Inc. 877.763.9566 or 801.886.9495
Emergency Contact: For Emergency information, contact Chemtel, Inc. at 800.255.3924, Outside the USA at 813.248.0585

Section 2
COMPOSITION & INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS Number	Weight % is less than	TLV-TWA	TLV-STEL	PEL-TWA	Skin Designation
Diethylene Glycol Monoethyl Ether	111-90-0	10.0% to 20%	No Info	No Info	No Info	Yes
Zinc Ammonium Carbonate Compound	38714-47-5	25% to 30%	No Info	No Info	No Info	No
Titanium Nano Drivers	13463-67-7	5% to 10%	No Info	No Info	No Info	No
Tributoxy Ethyl Phosphate	78-51-3	5% to 10%	No Info	No Info	No Info	Yes
Polymeric Hybrid Nano Particles	25586-24-7	1.0% to 3%	No Info	No Info	No Info	No
Plexi Acrylic Nano Fusion	9063-87-0	10% to 20%	No Info	No Info	No Info	No
Polycarbonate Nano Drivers	25037-45-0	15% to 25%	No Info	No Info	No Info	No
Hydrogen Hydroxide	7732-18-8	60% to 50%	No Info	No Info	No Info	No

CHEMICAL NAME
Diethylene Glycol Monoethyl Ether
Zinc Ammonium Carbonate Compound
Titanium Nano Drivers
Tributoxy Ethyl Phosphate
Polymeric Hybrid Nano Particles
Plexi Acrylic Nano Fusion
Polycarbonate Nano Drivers
Hydrogen Hydroxide

Courtesy Wikimedia

Safe Work Australia found SDSs lacking (2010)

- Nano metals, metal oxides, silicates and carbon nanotubes
- (84%) were “not sufficient to fulfill an appropriate risk assessment”
- Many presented data for the bulk material

67% of SDSs NIOSH collected in 2010-2011 "still provided insufficient data for communicating the potential hazards of ENM."

Date collected	Satisfactory	In Need of Improvement	In Need of Significant Improvement
2007-2008, n = 32	7 (21.8%)	13 (40.6%)	12 (37.5%)
2010-2011, n = 21	7 (33.3%)	10 (47.6%)	4 (19.1%)
2007-2008, recollected in 2010-2011, n = 23	4 (17.4%)	8 (34.8%)	**11 (47.8%)**

Eastlake, Hodson, Geraci and Crawford, J. Chem. H&S, Sept/Oct. 2012

Recent research into SDSs in the aerospace industry still paints a negative picture

Nayar et al. ,
J. Chem H&S, May/June 2016

Photo of Virgin Atlantic A340-600, courtesy Adrian Pingstone and Wikimedia

Nayar et al. looked at 200 SDSs from 89 suppliers

- 98 of chemicals were hazardous, 102 weren't (UK, COSHH regs 2002)
- Quality of SDS for hazardous was much lower
  - 46% had poor quality information
  - 1% had good quality

ISO has published a 2012 technical report for writing nano SDSs that is quite good and will be part of GHS!

ISO/TR 13329

Nanomaterials: Preparation of Material Safety Data Sheet (MSDS)

The ISO recommends a precautionary approach

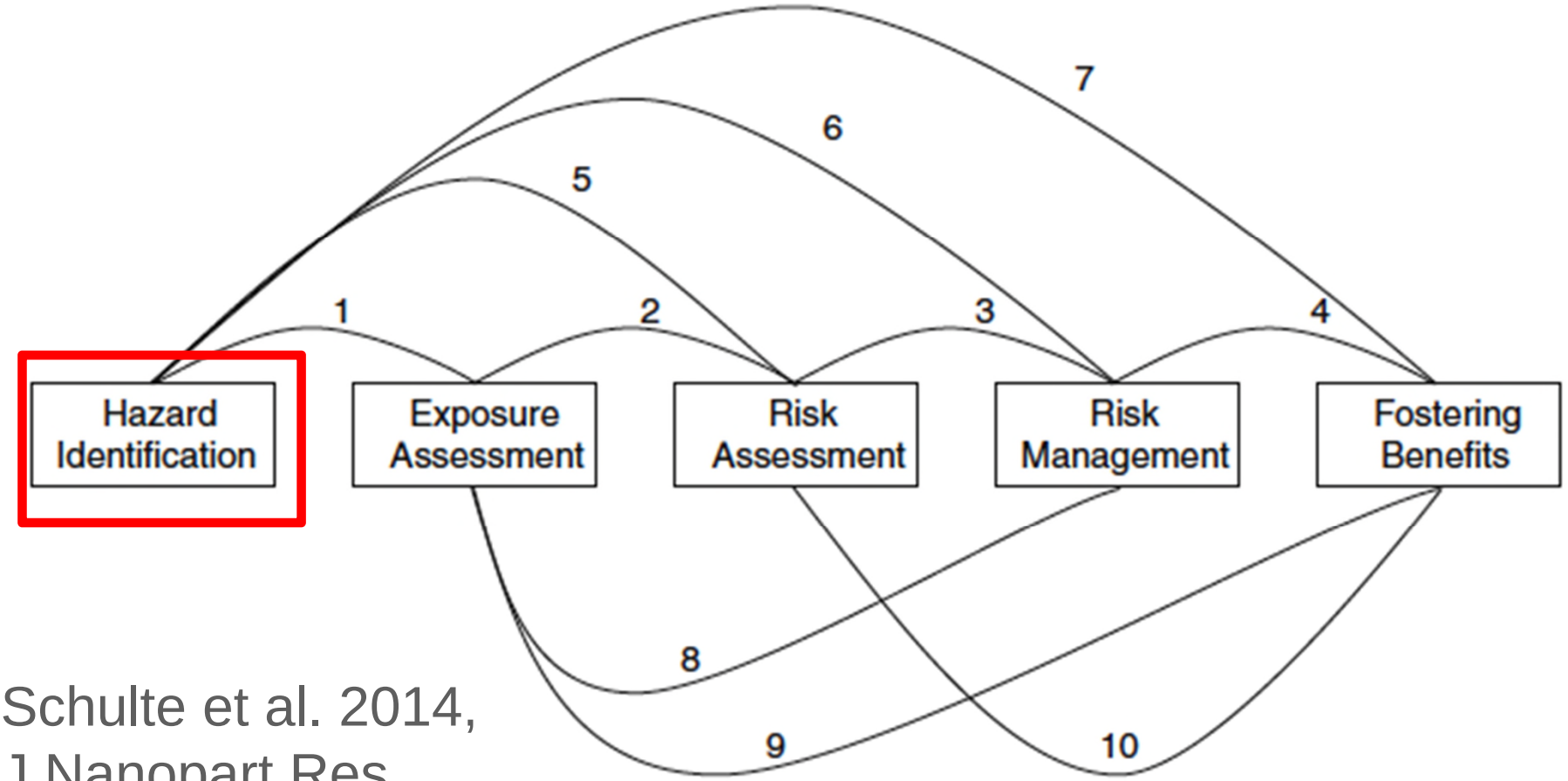
Provide an SDS for nanomaterials and nanomaterial-containing products *regardless* of whether the material is classified as hazardous

How informed are workers?

Question 3

1 2 3

NIOSH's concept of responsible nanotechnology development *hinges* on hazard identification



Schulte et al. 2014, J.Nanopart Res.

CPWR surveyed 79 worker-trainers from 22 trades with an average of 30 years in the trade

(2013-2014)

Survey Respondent Characteristics	N	Mean	SD	Range
Years in trade	78	30.5	9.4	9-55
Years as a trainer	79	13.3	7.8	1-34

Nearly half were not aware that nano had been applied to construction materials

	Yes	No
Aware that nanotechnology has been applied to construction materials?	**41 (52%)**	**38 (48%)**
Aware that construction products containing nanomaterials are commercially available in the USA?	**38 (48%)**	**41 (52%)**

Only 3 out of 79 had heard of NIOSH's Nano RELs

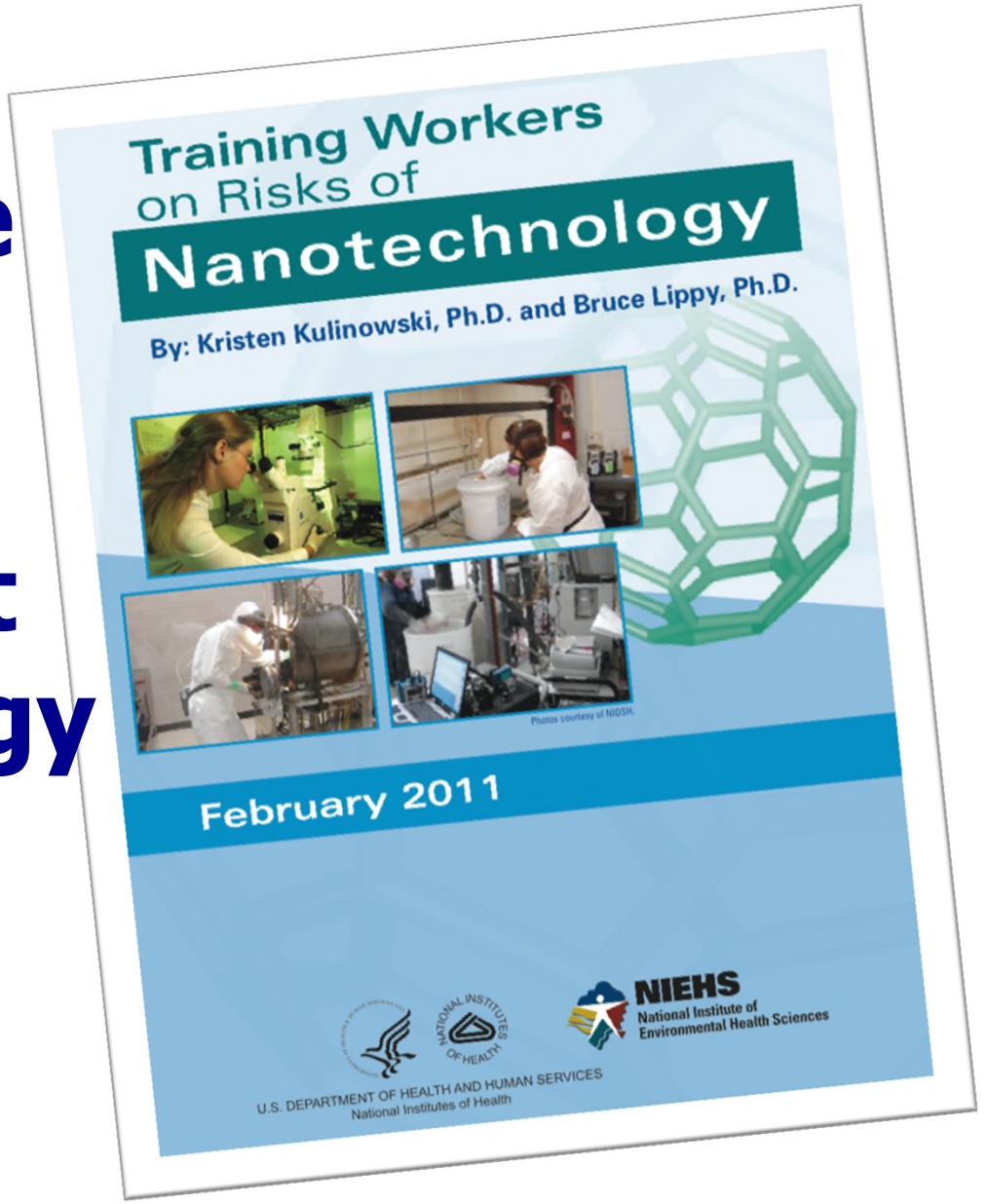
Nanomaterial	OEL (mg/m^3)	Year
Titanium dioxide	0.3 ultrafine 2.4 fine	2011
CNTs and nanofibers	0.001	2013

How should workers be trained about nanomaterials?

Question 4

1 2 3 4

NIEHS has the only guidance on training workers about nanotechnology risks



The guidance identified possible exposures among specific populations

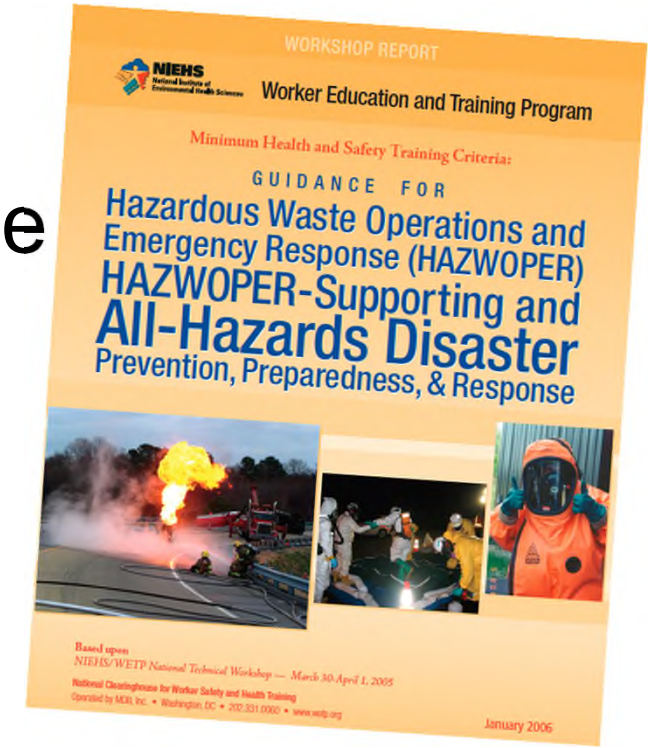
Worker Population	Type of Nanomaterial	Tasks
Stationary engineers	Nanosilver biocides	Adding biocides to cooling tower water and drip pans
Cleanup workers	Nanoparticles in hazardous waste	Performing cleanup of waste sites
Nurses and physicians	Nanosiliver in disinfectants	Preparing intravenous liquids

The NIEHS guidance also provided:

1. Suggested learning objectives for a nanomaterials course for workers
2. Outline for 8-hour HAZWOPER refresher
3. Value of NIEHS Minimum Criteria in structuring nanoparticle training for workers

The NIEHS WETP Minimum Criteria provides guidance on key elements of worker training

- Worker training principles
- Characteristics of excellence
- Program design and QC



Available at the National Clearinghouse for Worker S&H Training

An 8-hour course is available for free at two locations

The GoodNanoGuide

www.goodnanoguide.org

OSHA Training Institute

Target audience was H&S professionals

The course has a nano-SDS exercise we continue to use for union trainers

1. Is nano mentioned?
2. Is there any cautionary language?
3. Is the OEL for the parent material?

Machinists doing SDS exercise, Aug 2016

Working with nano?
What you need to know and who to talk to

In every workplace using nanomaterials, it's important to ensure appropriate risk evaluation for *each* nanomaterial used.

Help your safety representative answer these questions...

1 Are manufactured nanomaterials used in your workplace?

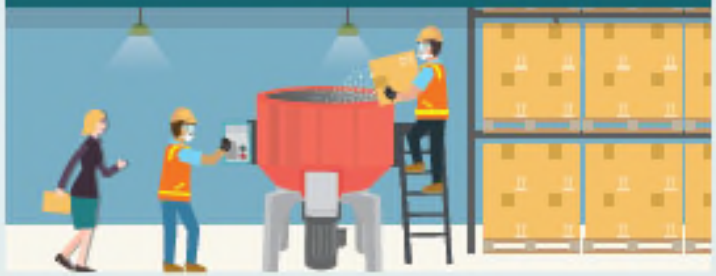
Your employer is legally required to provide information on the specific substance used, like: titanium dioxide, nanosilver, carbon nanotubes, synthetic amorphous silica

2 What shape is the nanomaterial? What chemical is it made of?

1 dimension

2 dimensions

3 dimensions

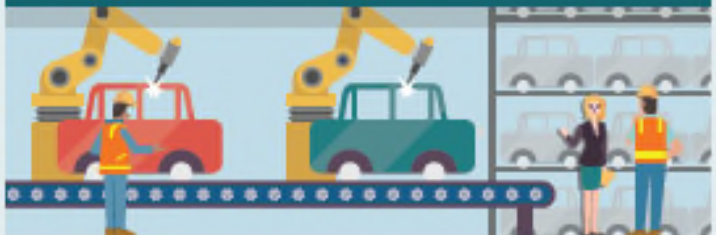


3 Has your employer done a risk assessment on using the nanomaterial at your workplace?

- Ask your employer for the Safety Data Sheet of the nanomaterial
- Is the risk assessment complete?
- What do you think is missing in the risk assessment?
- Is the risk assessment useful to provide guidance on measures to prevent worker exposure

4 Could nanomaterials be released when you are working?

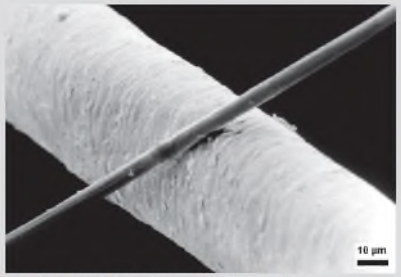
- As a powder
- As part of a solution or mixture
- As part of a nano-enabled product (e.g. sawing, sanding, cutting, grinding or using a product containing nanomaterials)



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

PHOTO CREDIT: ANTON/WIKIMEDIA COMMONS/CC-BY-SA-3.0/GFDL (ORIGINAL UPLOAD OCT 2004 GERMAN WIKIPEDIA)

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.**

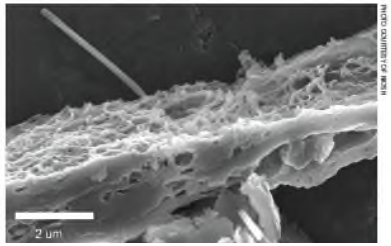


PHOTO COURTESY OF NIOSH

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.

PHOTO COURTESY OF NORTH HONEYWELL

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

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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HAZARD ALERT
NANOMATERIALS

It is electronically available in Spanish

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.

Los productos de construcción que pueden contener nanomateriales incluyen:

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

elcosh NANO

www.nano.elcosh.org

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 especifico 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

What are the key messages for workers?

1. There are still questions about the health risks
2. Exposures to ENPs in construction appear to be below OELs
3. Local exhaust ventilation can greatly reduce construction exposures, including to nano-objects
4. Respirators can capture ENPs
5. SDSs for nano products are inadequate and shouldn't be relied upon
6. NIOSH is your best source of info

The AIHA Nanotechnology Working Group could be a valuable resource

Thanks! Questions?

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