CPWR

THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Nanomaterials in Construction Webinar: CPWR Research and Resources

elcosh NANO

Construction Nanomaterial Inventory

nanoSDS

November 16, 2023

Moderator: Doug Trout, MD, MHS, Medical Officer, NIOSH

Panelists

Gavin West, MPH, Director, Nanomaterials Research, CPWR

Bruce Lippy, PhD, CIH, CSP, President, The Lippy Group, LLC, and consultant to CPWR

William Harris, MS, Research Analyst, Data Center, CPWR

After today, you will be able to:

- Summarize what is known about the use of nanomaterials in construction, exposure risks, and controls.
- Use CPWR resources to identify and manage risks posed by nanomaterials and increase awareness.

What is nanotechnology?

About Nanotechnology

https://www.nano.gov/about-nanotechnology

"Nanotechnology is the **understanding and control of matter** at the nanoscale, at dimensions **between approximately 1 and 100 nanometers**, where unique phenomena enable novel applications."

Nanoscale materials can have unusual physical, chemical, and biological properties

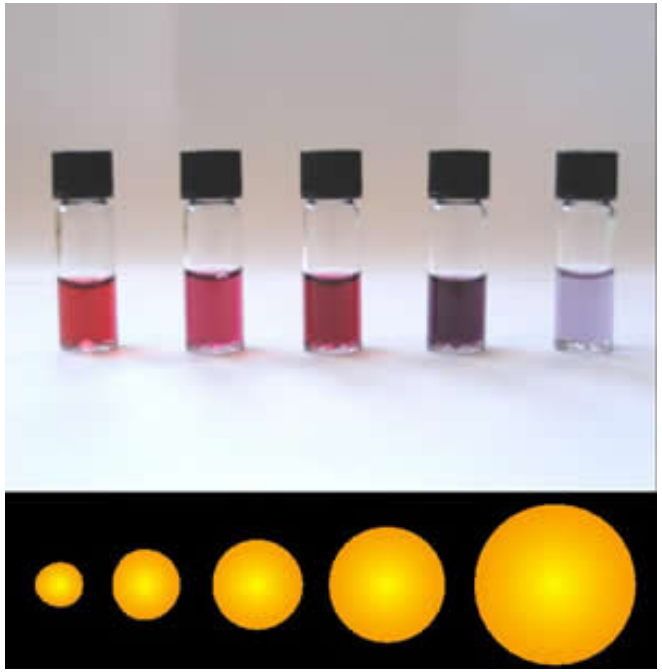


Image by: Aleksandar Kondinski via Wikimedia Commons

Nanoscale gold can be:

Red

Purple

Magnetic

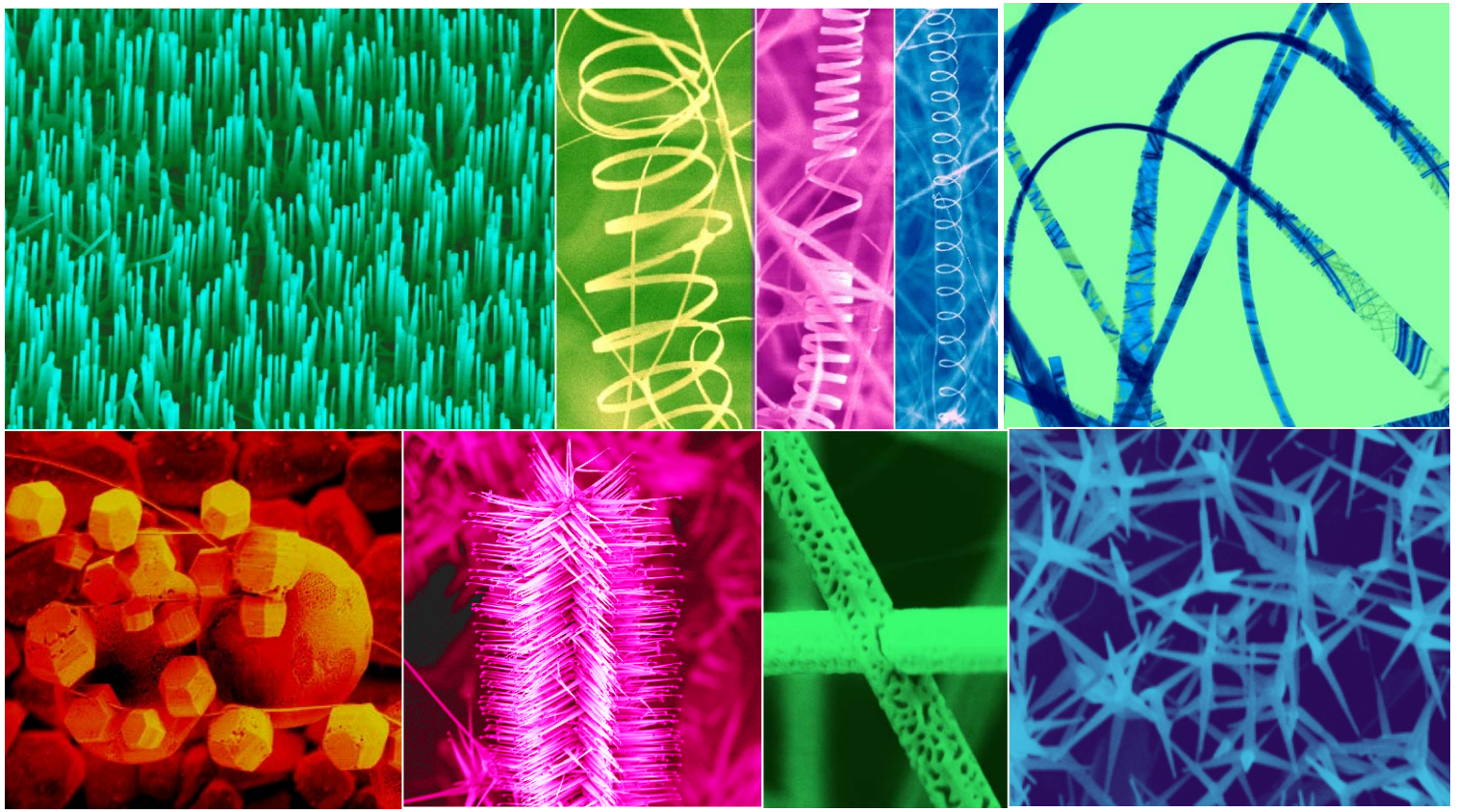
Explosive

One atom of gold is about one third of a nanometer in diameter!

A yard is roughly a meter

Think about cutting that into a billion sections

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

Ultrafine particles (< 100nm) also occur naturally or can be created unintentionally

A growing body of evidence suggests ultrafine particles may play a bigger role inflicting adverse health impacts than recognized previously, including effects on the brain

Environmental Science & Technology

pubs.acs.org/est

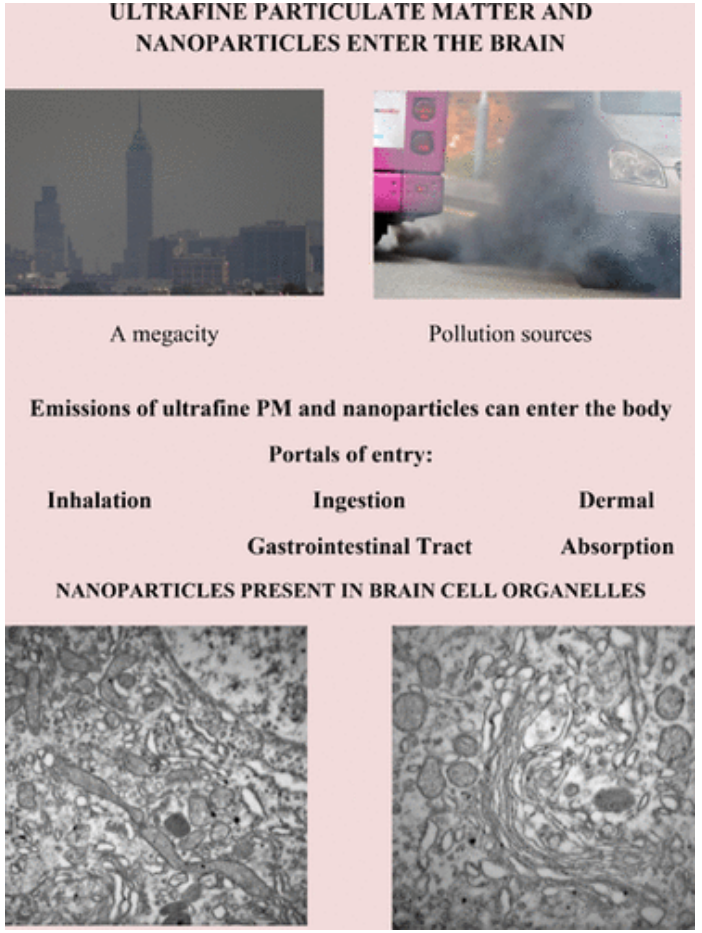
Perspective

Air Pollution, Ultrafine Particles, and Your Brain: Are Combustion Nanoparticle Emissions and Engineered Nanoparticles Causing Preventable Fatal Neurodegenerative Diseases and Common Neuropsychiatric Outcomes?

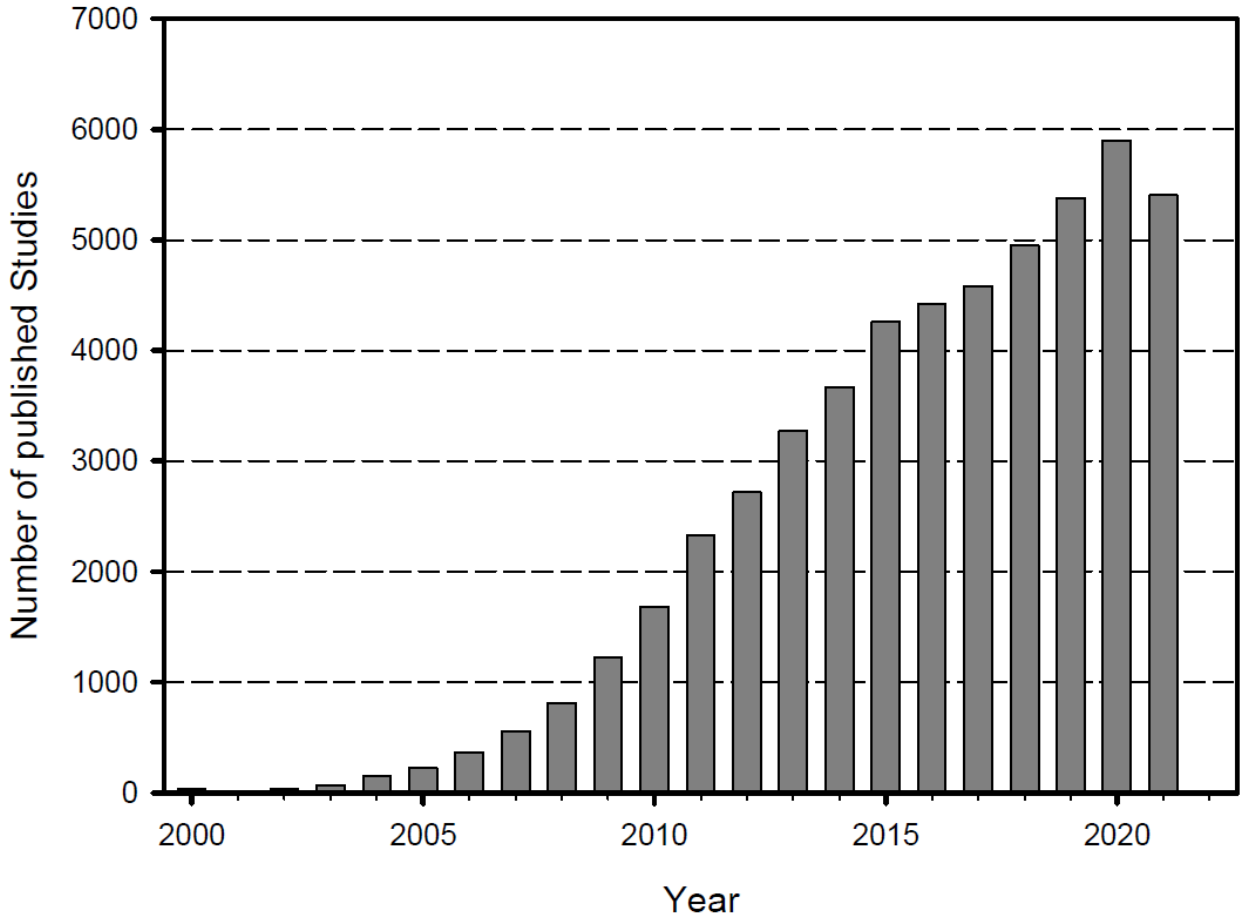
Lilian Calderón-Garcidueñas and Alberto Ayala*

Cite This: *Environ. Sci. Technol.* 2022, 56, 6847−6856

Read Online



Over 40,000 nanotoxicology studies have been published over the last two decades



Krug HF. Collection of Controlled Nanosafety Data-The CoCoN-Database, a Tool to Assess Nanomaterial Hazard. Nanomaterials (Basel). 2022 Jan 28;12(3):441.

Compared to larger particles of the same chemical composition, nanoparticles can:

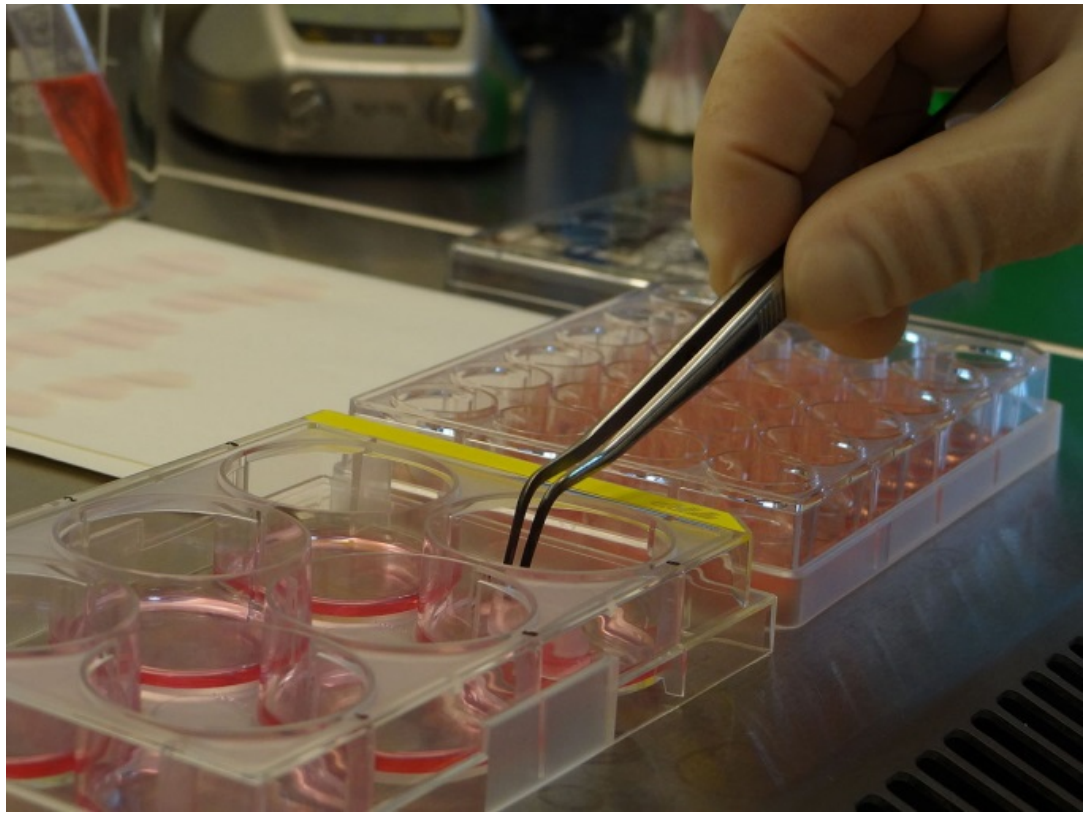


Image courtesy of Wikimedia Commons

- Exhibit increased toxicity
- Be more likely to deposit in the respiratory tract
- Cross cell membranes
- Penetrate healthy intact skin in some cases and translocate to other organs
- Present fire or explosion hazards

Are all nanomaterials and nanomaterial-containing products inherently toxic?

☐ YES

☒ NO

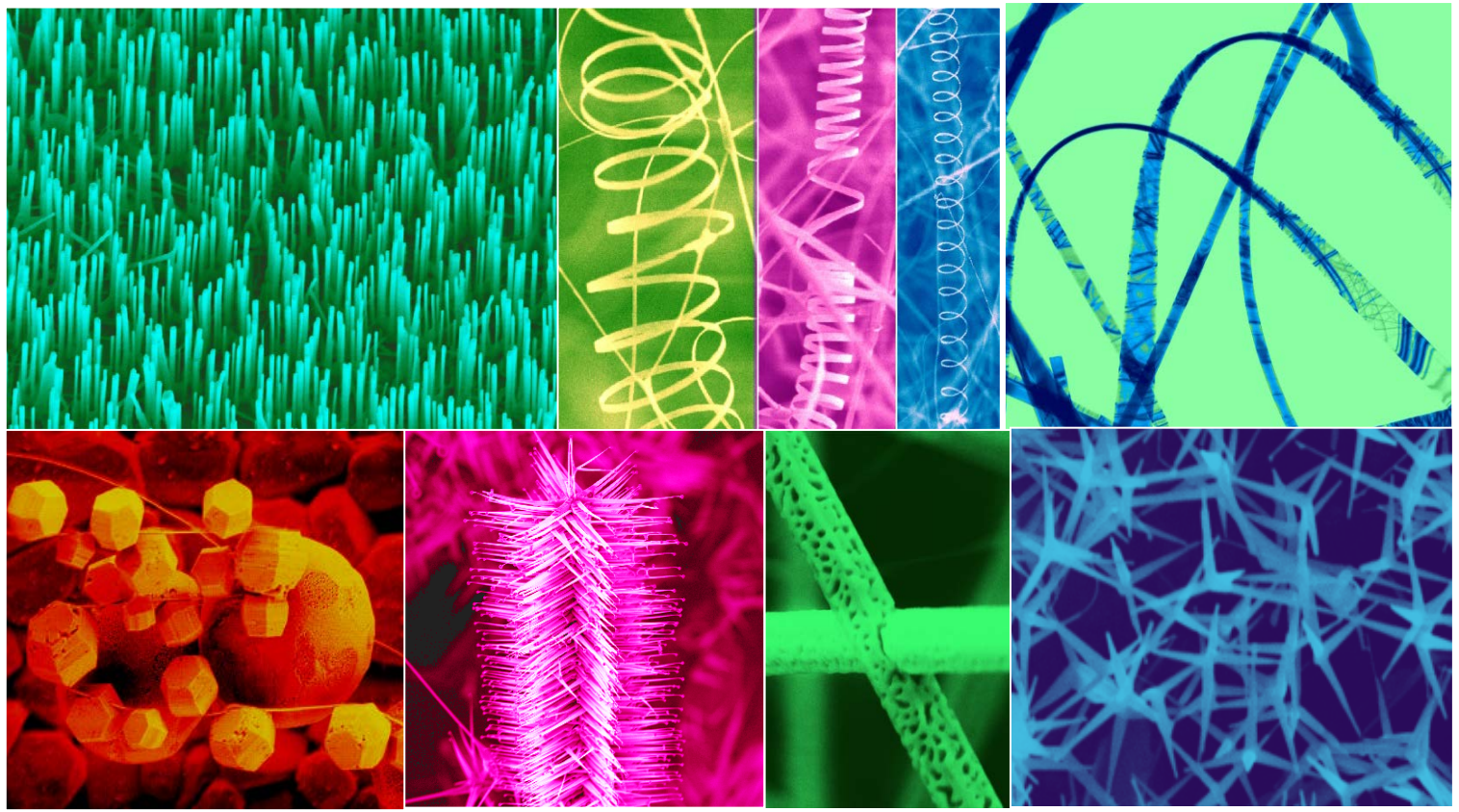
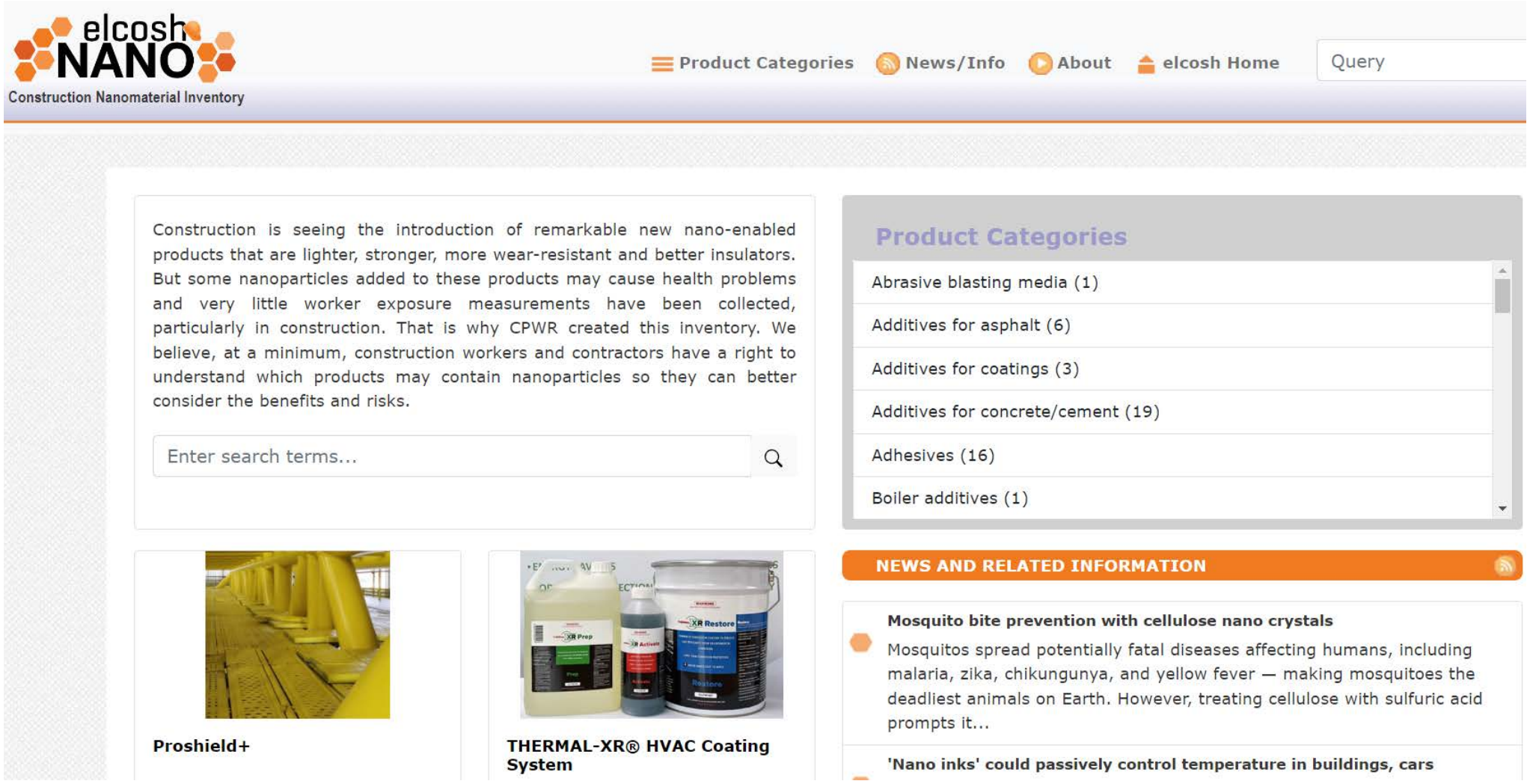


Image courtesy Dr. Zhong Wang, Georgia Tech

CPWR researchers and collaborators have been working to answer these questions

- Based on available products, where is there potential for exposure?
- What forms of ENMs are released from construction materials?
- What levels of exposure are likely during different tasks?
- Do these exposures exceed OELs or pose health risks?
- Are exposure controls effective?

CPWR maintains the most comprehensive source of information on reported use of nanomaterials in construction (https://nano.elcosh.org/)



Toxicology and exposure studies have primarily examined nanomaterials before they are added to products like coatings or cement

Photo courtesy: NIOSH and Nanocomp Technologies, Inc.

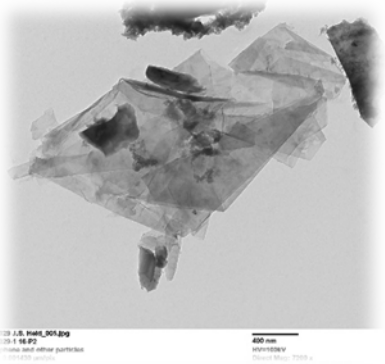
VERSUS

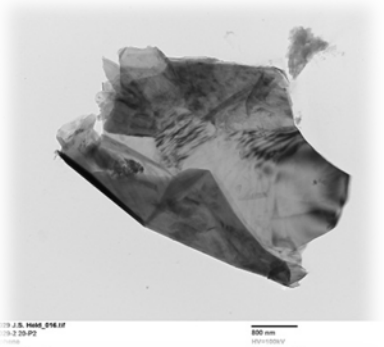
Enclosed furnace used to produce carbon nanotubes

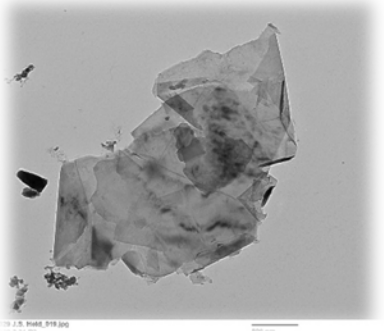
Photo courtesy: VA Dept of Transportation

Enclosure for bridge lead abatement

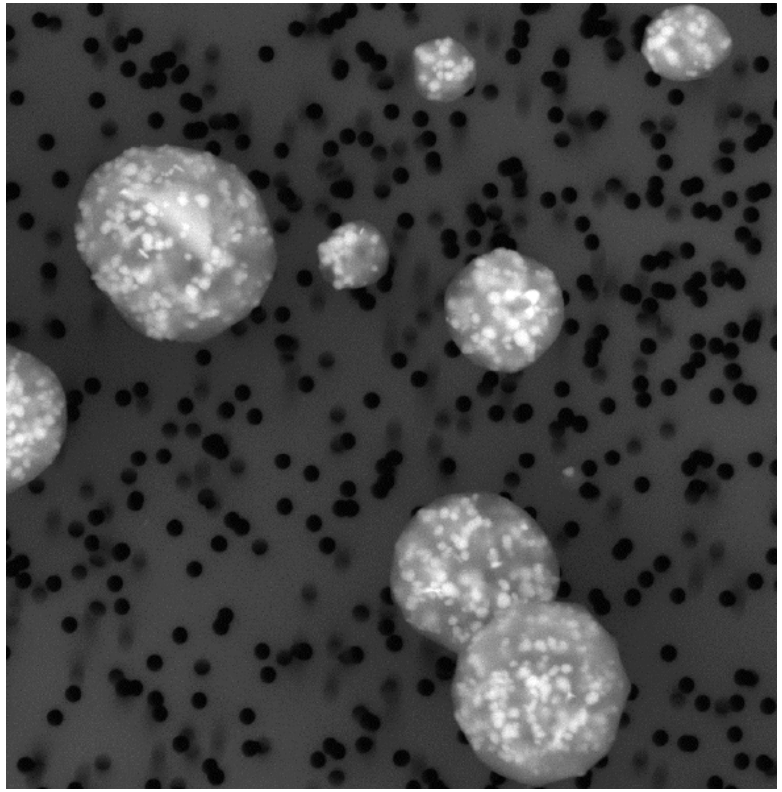
CPWR has studied release of ENMs from construction products and measured exposure levels during a range of tasks



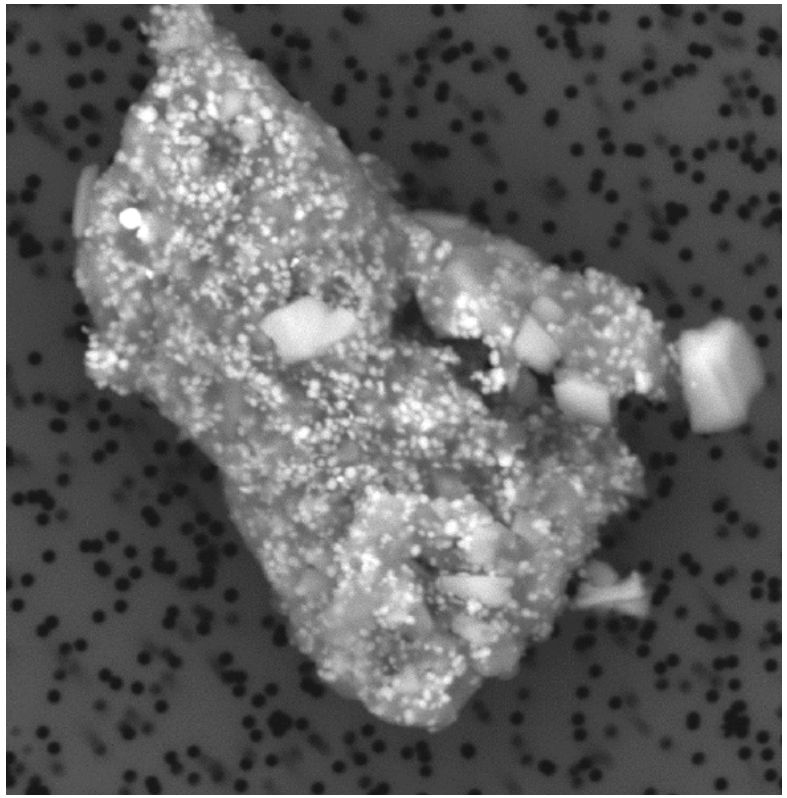




Most studies show that ENMs tend to remain embedded in the construction materials to which they are added…



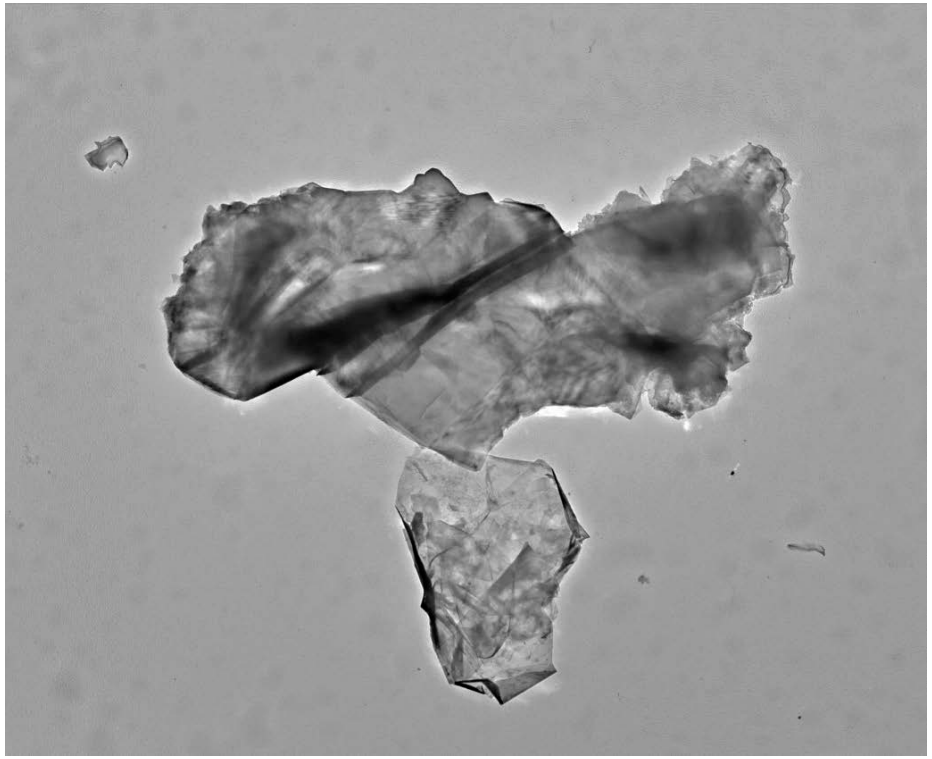
Paint spray with white nanoparticles



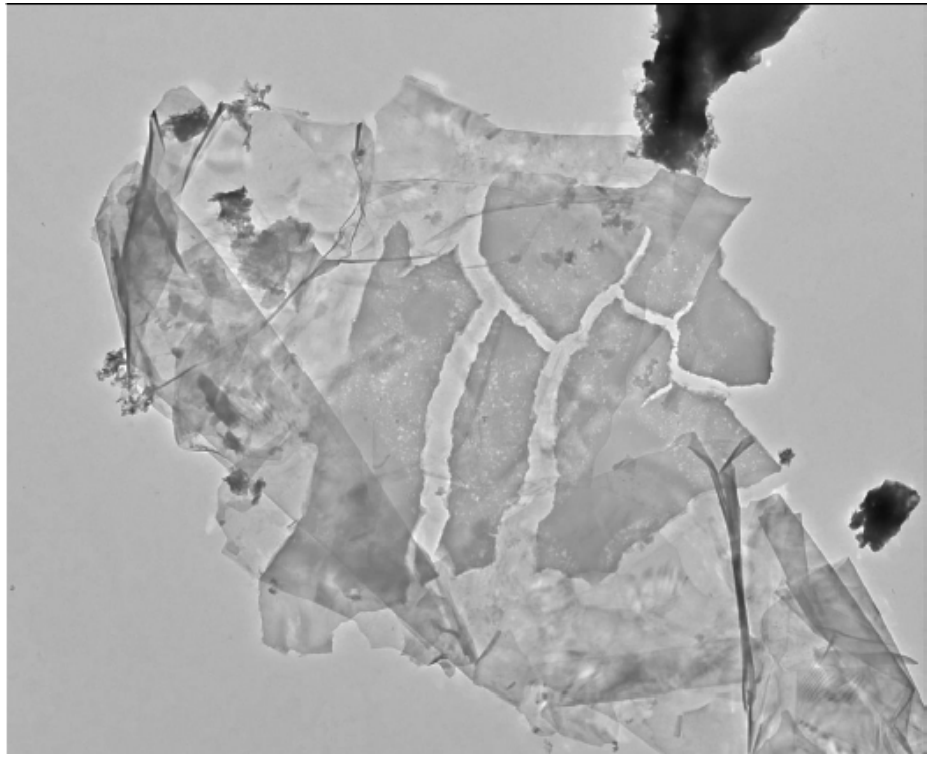
Sanding debris with white nanoparticles

… but we have also observed release of free ENMs during construction activities

Graphene before it was added to mortar



Graphene released during tuckpointing



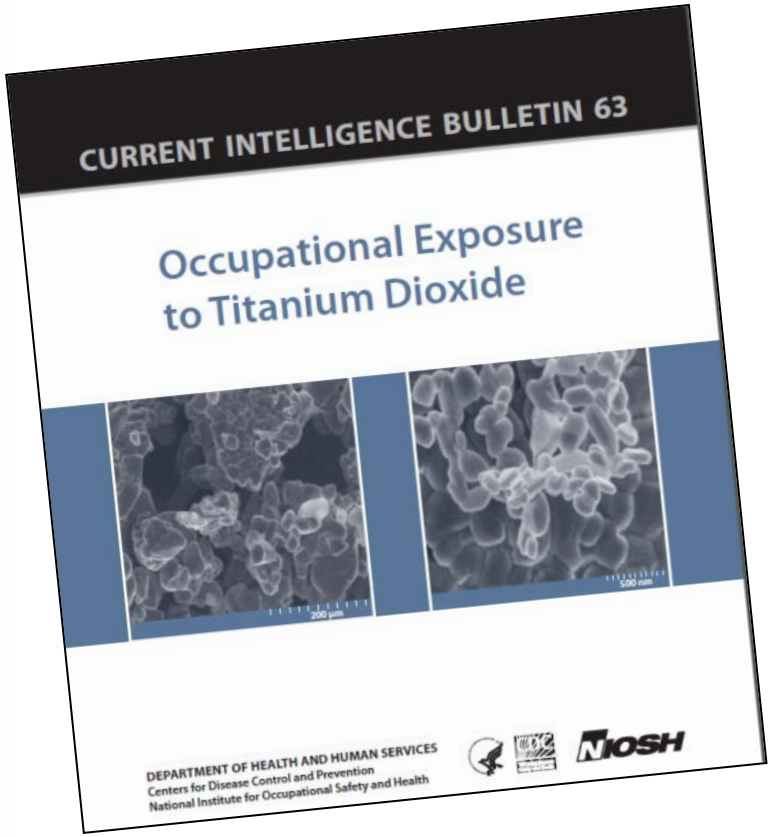
NIOSH has three Recommended Exposure Limits (RELs) for nanomaterials

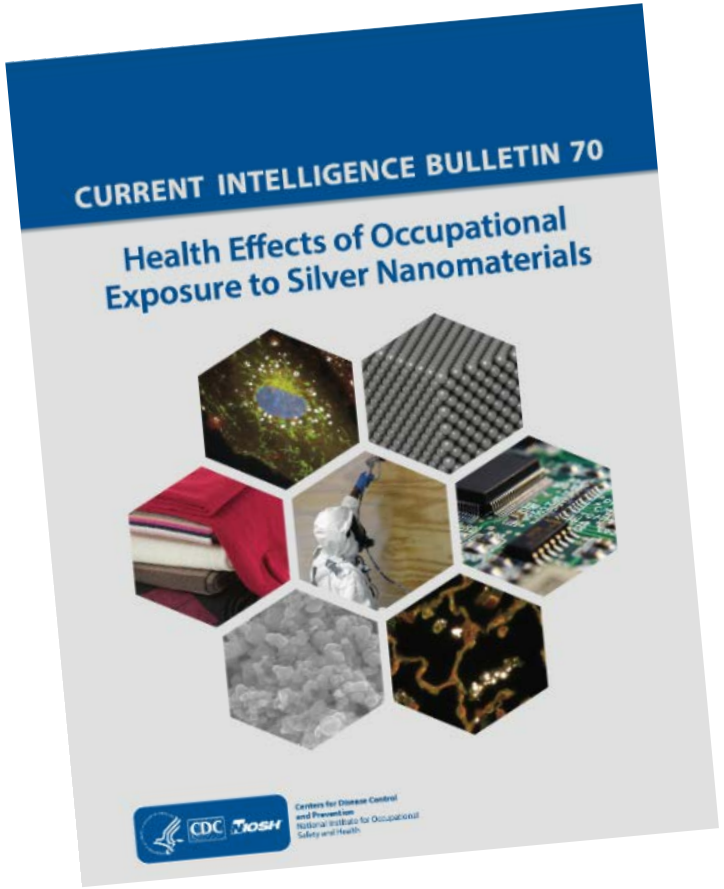
1. Carbon Nanotubes and Nanofibers
2. Titanium Dioxide
3. Silver

OSHA does not have any Permissible Exposure Limits (PELs) for nanomaterials

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

CPWR studies show potential to exceed NIOSH RELs during airless spraying of paint





CPWR collaborates with NIOSH Health Effects Laboratory Division researchers to conduct integrated exposure and toxicity research

Image courtesy Earl Dotter

Dr. Jenny Roberts (NIOSH) speaks with a CPWR study participant through an observation window of the test chamber

Some good news is that CPWR studies show that engineering controls effectively reduce nanoparticle exposures

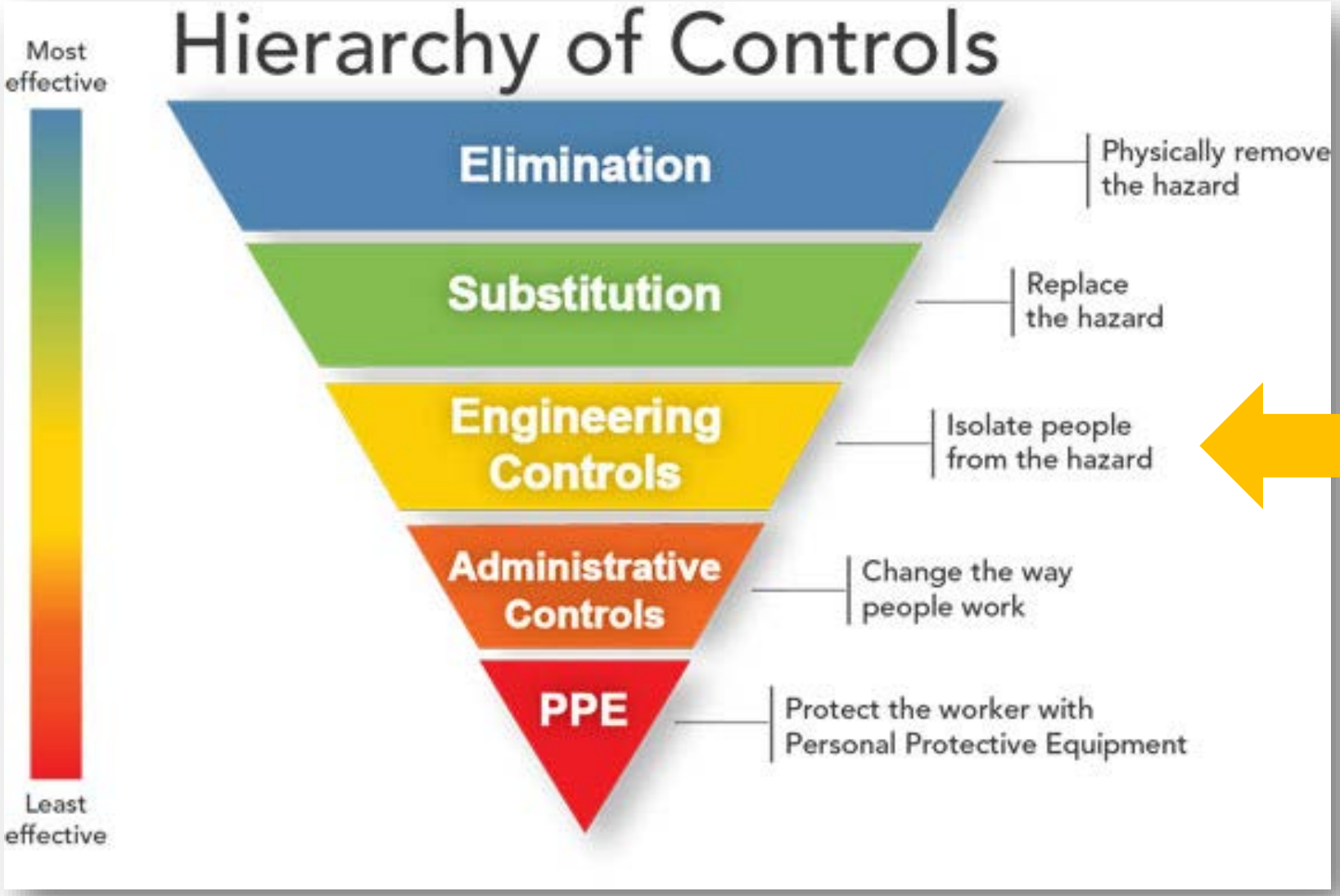
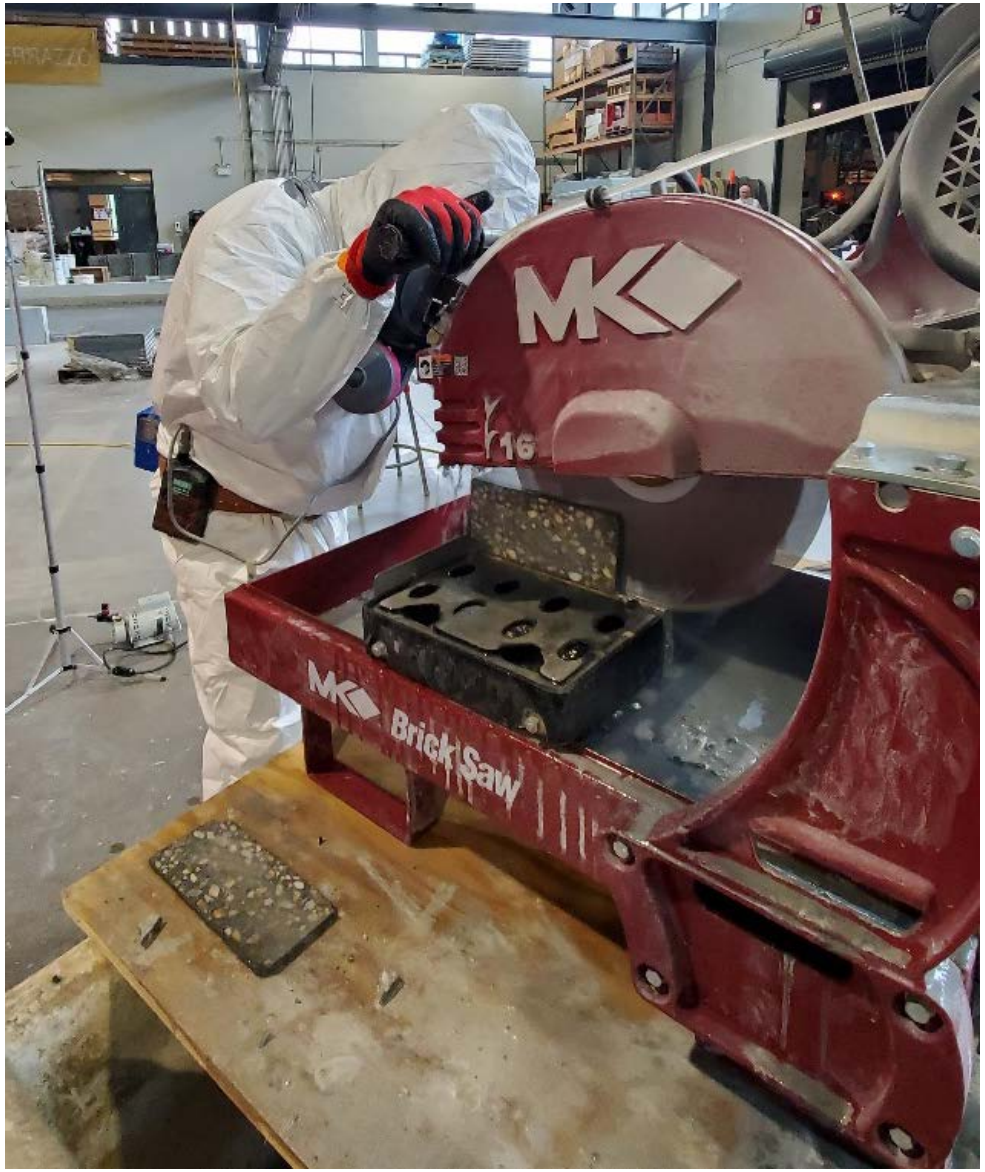


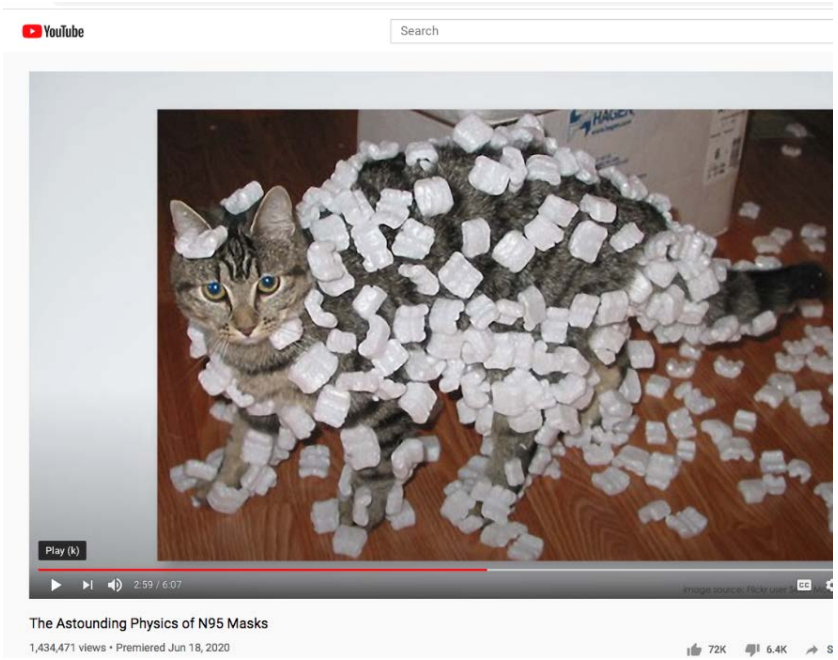
Photo courtesy
Earl Dotter

We found that wet methods work too



And Yes! HEPA filters capture nanoparticles

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

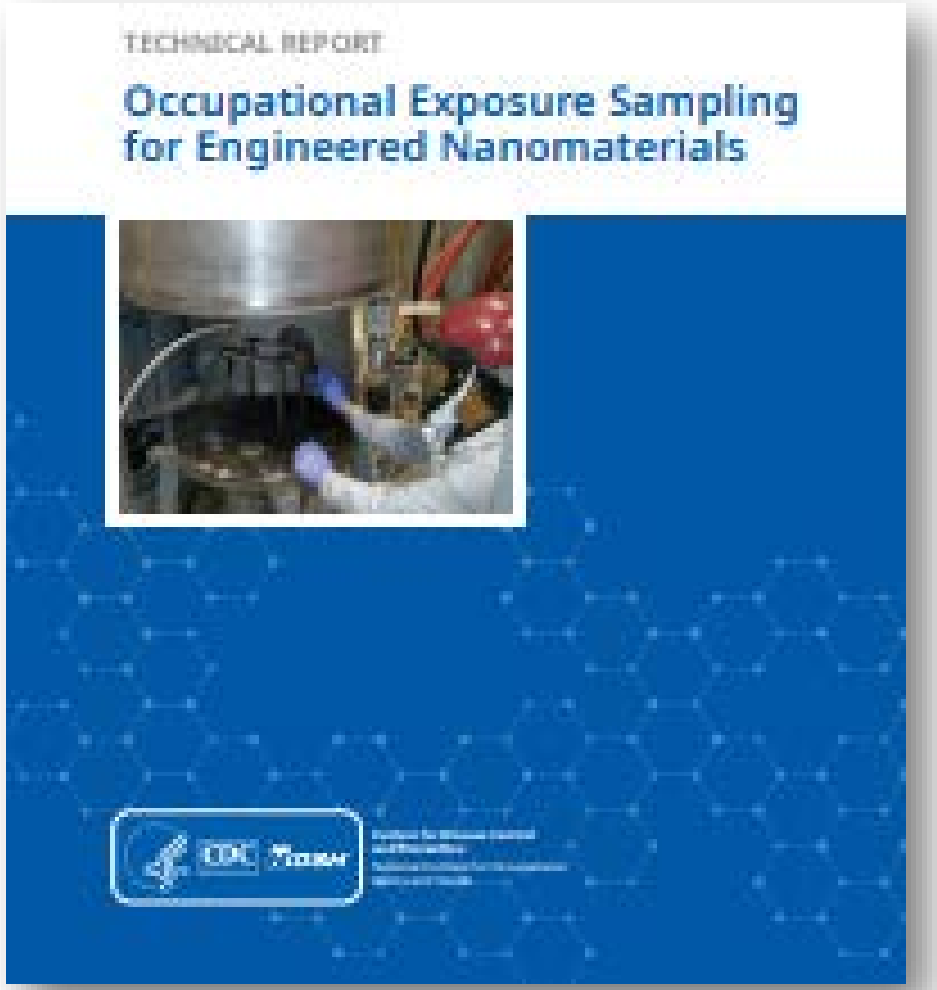


Great video on how filtration works!

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

Images courtesy 3M Corp and Wikimedia Commons

NIOSH published helpful new guidance last year



Exposure Monitoring Program goals:

- Maintain exposures below NIOSH RELs
- Minimize exposure to ENMs without RELs

OSHA supports these NIOSH recommendations and specifies existing OSHA standards that may be applicable to nanomaterials

1. https://www.cdc.gov/niosh/docs/2022-153/
2. https://www.osha.gov/sites/default/files/publications/OSHA_FS-3634.pdf

Nanomaterials in Construction: CPWR Resources

Bruce Lippy PhD, CIH, CSP

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Status of hazard communication for nano

“MSDSs Fail to Communicate the Hazards of Nanotechnology to Workers”

October 2009 EPA-sponsored International Nanotechnology Conference, Chicago, IL

Safe Work Australia found SDSs lacking (2010)

- **Evaluated 50 SDSs**
- **18% (9/50) “were assessed as providing reliable information to appropriately inform an occupational risk assessment”**

Safe Work Australia (SWA). 2010. *An Evaluation of MSDS and Labels associated with the use of Engineered Nanomaterials*. Commonwealth of Australia.

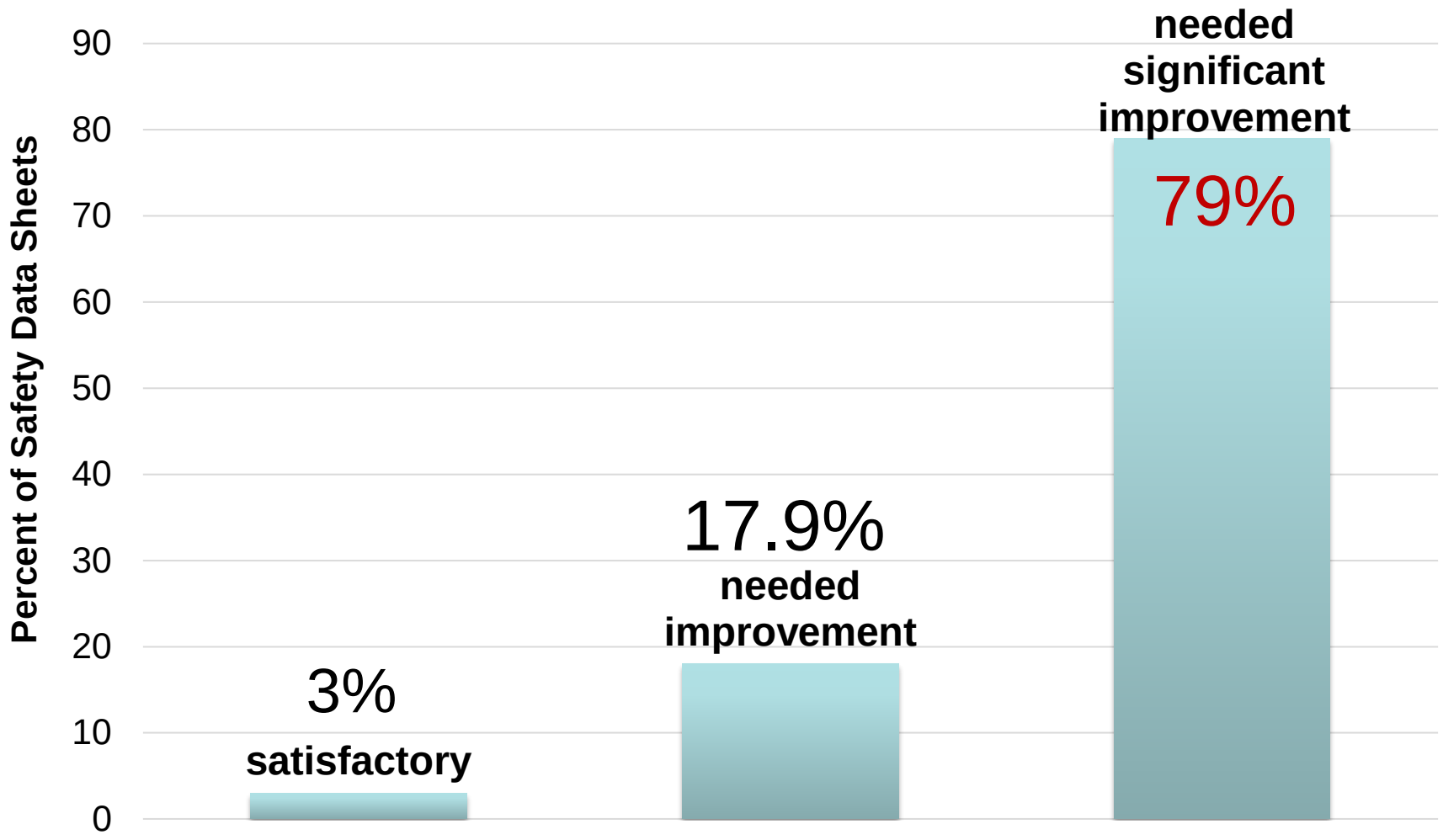
Ji Hyun Lee and colleagues' work in 2012 led to ISO TR 13329

- Evaluated 97 SDS by GHS criteria
- Info missing on routes of entry, toxicology, and protective measures
- Widespread use of OELs for the bulk forms

Lee et al. (2012) Nanotoxicology

Evaluation of information in nanomaterial safety data sheets and development of international standard for guidance on preparation of nanomaterial safety data sheets

A 2019 NIOSH study of 67 SDSs using 2 criteria found serious problems with nano safety data sheets



Hodson, Eastlake & Herbers, 2019

We have seen little useful information on nano in SDSs we've collected

- >900 products in eLCOSH currently
- We frequently don't see information about nanomaterials in the SDS

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Construction Nanomaterial Inventory

There is currently no requirement to identify nanomaterials in safety data sheets (SDSs)


NANO TECH COATINGS

SAFETY DATA SHEET

CIRCUIT COATING

Product Identification

Product Name: NanoTech Circuit Coating

Composition

NFPA Est. Health: 1 Fire: 2 React: 1

HMIS Est. Health: 1 Fire: 2 React: 1

Ingredient	Concentration	C.A.S. Number	ACGIH TLV	OSHA PEL
Trade Secret A-1	23-25	Proprietary	1000 ppm	n/a
Trade Secret A-2	9-10	Proprietary	10 ppm	100 ppm
Ethyl Alcohol	9-10	64-17-5	1000 ppm	1000 ppm
Butyl Acetate	36-39	540-88-5	200 ppm	200 ppm
Trade Secret B	13-16	Proprietary	n/a	n/a

Chemical and Physical Properties

Vapor pressure: 9 hPa @ 20° C
Solubility in Water: Insoluble
Boiling Point: >90° C
Odor: Mild fruity
Vapor Density: Heavier than air
Specific Gravity: 1.02
Appearance: clear to slightly milky liquid
V.O.C. <100 gm/liter

Flammability and Explosive Properties

Flash Point: <25° C (77 F)
Recommended Extinguishing Agents: Use water spray, foam, dry chemical or CO2
Hazardous Products Formed by Fire or Thermal Decomposition: Hazardous fumes (ethanol, phenolics, oxides of carbon and nitrogen)
Unusual Fire or Explosion Hazards: Flammable
Compressed Gasses: None
Pressure at Room Temp: N.A.

Reactivity Data

Stability: Stable
Hazardous Polymerization: May occur
Hazardous Decomposition Products: Ethanol
Incompatibility: Oxidizers, alkalis, acids, aliphatic amines, nitrates, water

Made in USA

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

Under REACH, the registration dossier for nano must include

- Size
- Shape
- Aspect ratio
- Assembly structure
- Rigidity
- Crystallinity
- Surface functionalization
- Surface area

https://echa.europa.eu/regulations/nanomaterials

Upcoming revisions to OSHA's Hazcom standard should improve Nano SDSs

To meet the requirements of the Global Harmonization System, manufacturers must report particle size and "If available and appropriate"

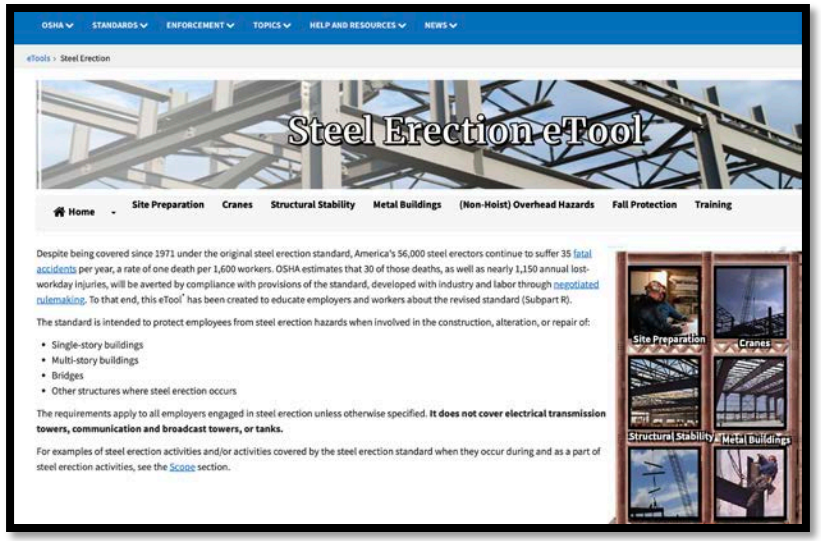
- Shape
- Aspect ratio
- Surface area

There is good guidance available for writing Nano SDSs (ISO/TS 13329)

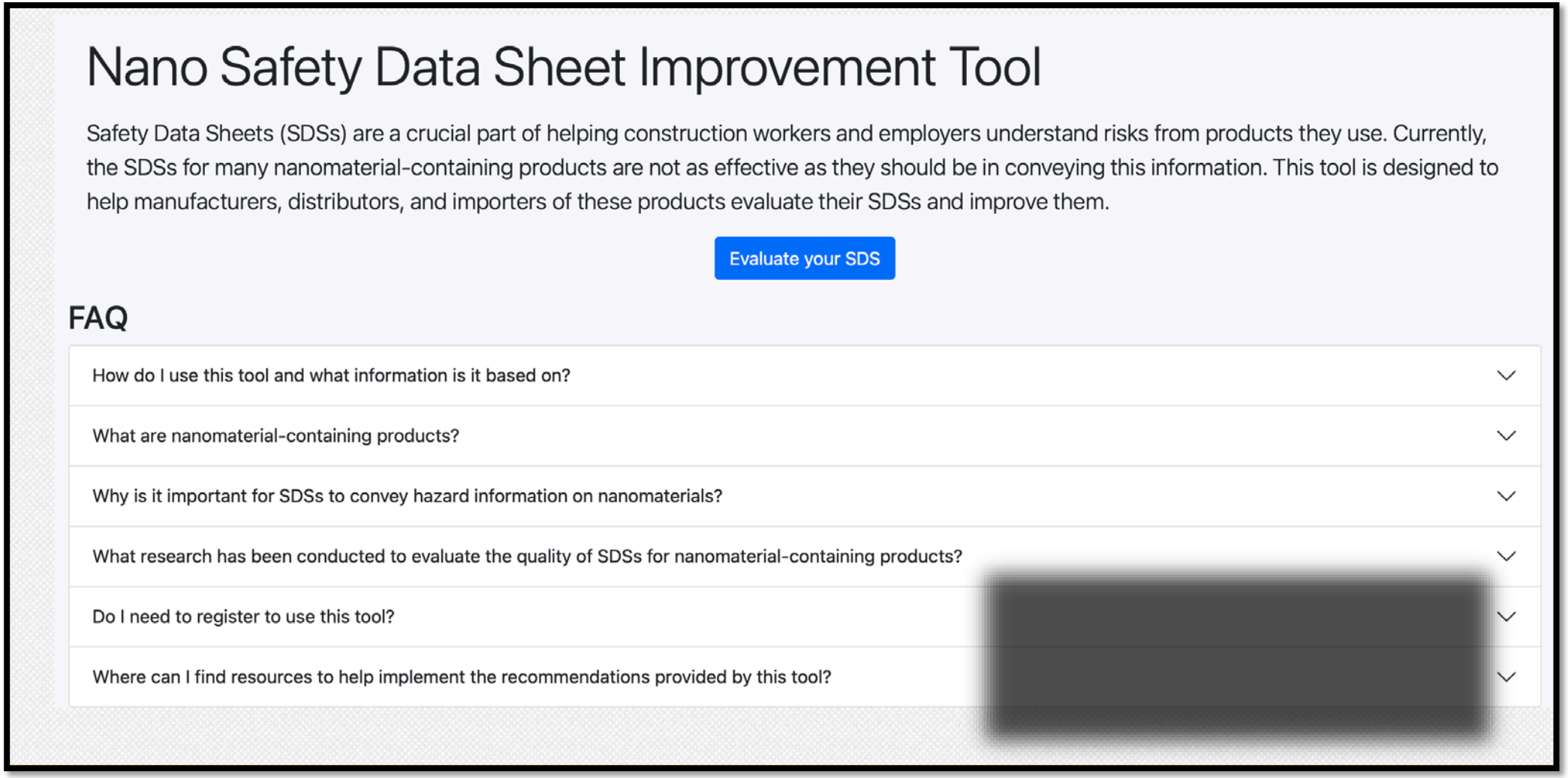
Provide an SDS for nanomaterials and nanomaterial-containing products *regardless* of whether the material is classified as hazardous

My suggestions to the OSHA Advisory Committee on Construction Safety and Health 11-27-12

Create an eTool on nano SDSs



CPWR has recently posted SDS guidance



https://nanosds.elcosh.org

CPWR has created trade-specific training materials for Train-the-Trainer sessions

Gavin speaking to the IUOE

We have integrated a 6-month survey to see if trainers are using our nano curriculum.

They are!

- 37 trainers responded
- A subset included our materials in 49 courses reaching 820 students
- Looking for other homes for our curriculum, e.g. The Good Nano Guide

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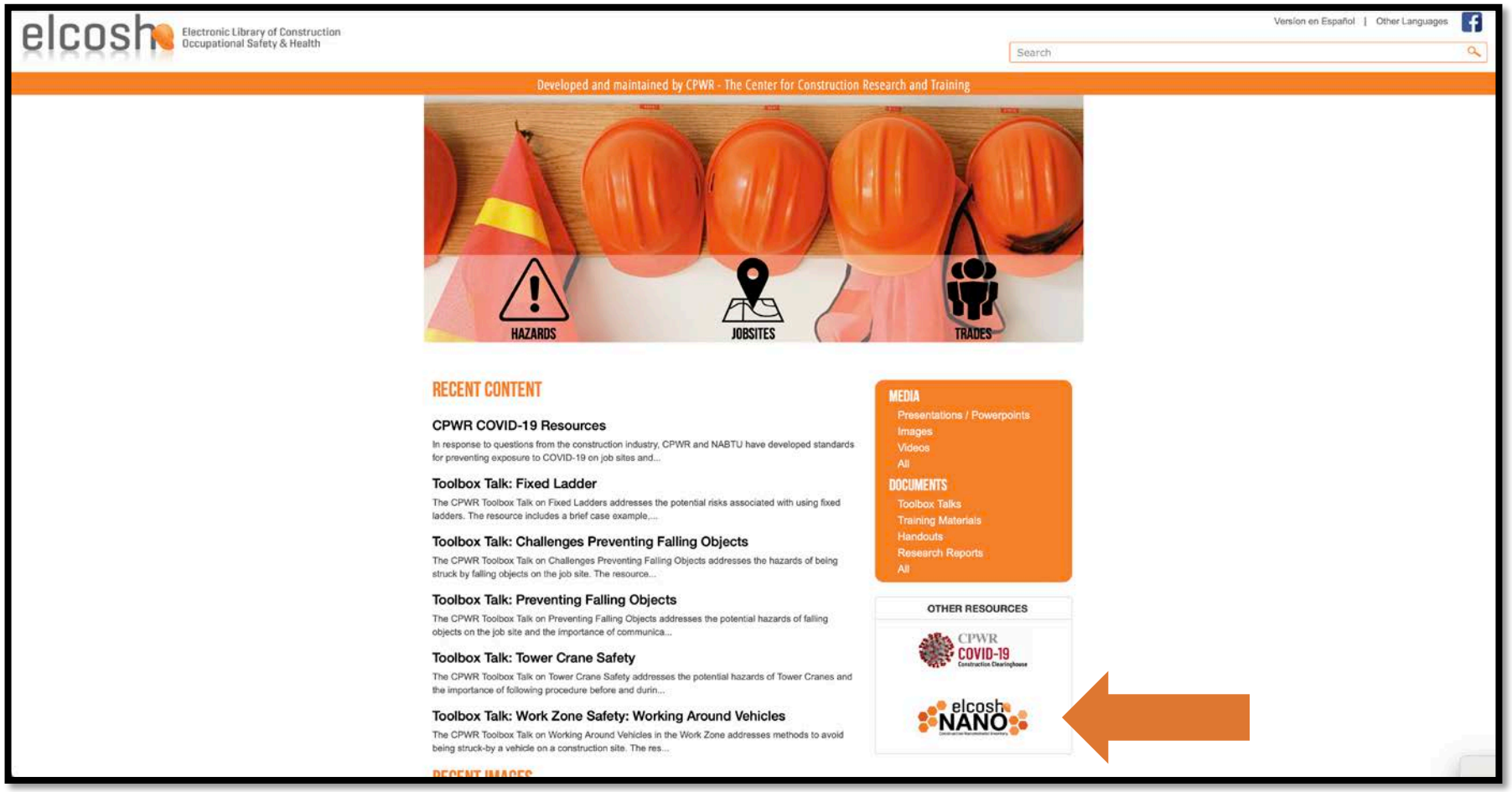
Construction Nanomaterial Inventory

Other Resources



Electronic Library of Construction Safety and Health (eLCOSH) https://elcosh.org

We continue adding to our collection of nano toolbox talks, 30,000 have been downloaded over last 5 years

Photo courtesy: Morgan Zavertnik and Hoar Construction

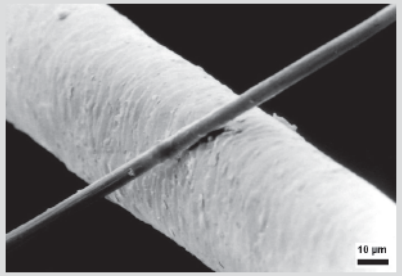
https://www.cpwr.com/research/research-to-practice-r2p/r2p-library/toolbox-talks/

5,000 nano cards in print and electronic downloads

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)

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.

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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

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

http://www.cpwr.com

ADVERTENCIA DE PELIGRO

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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?

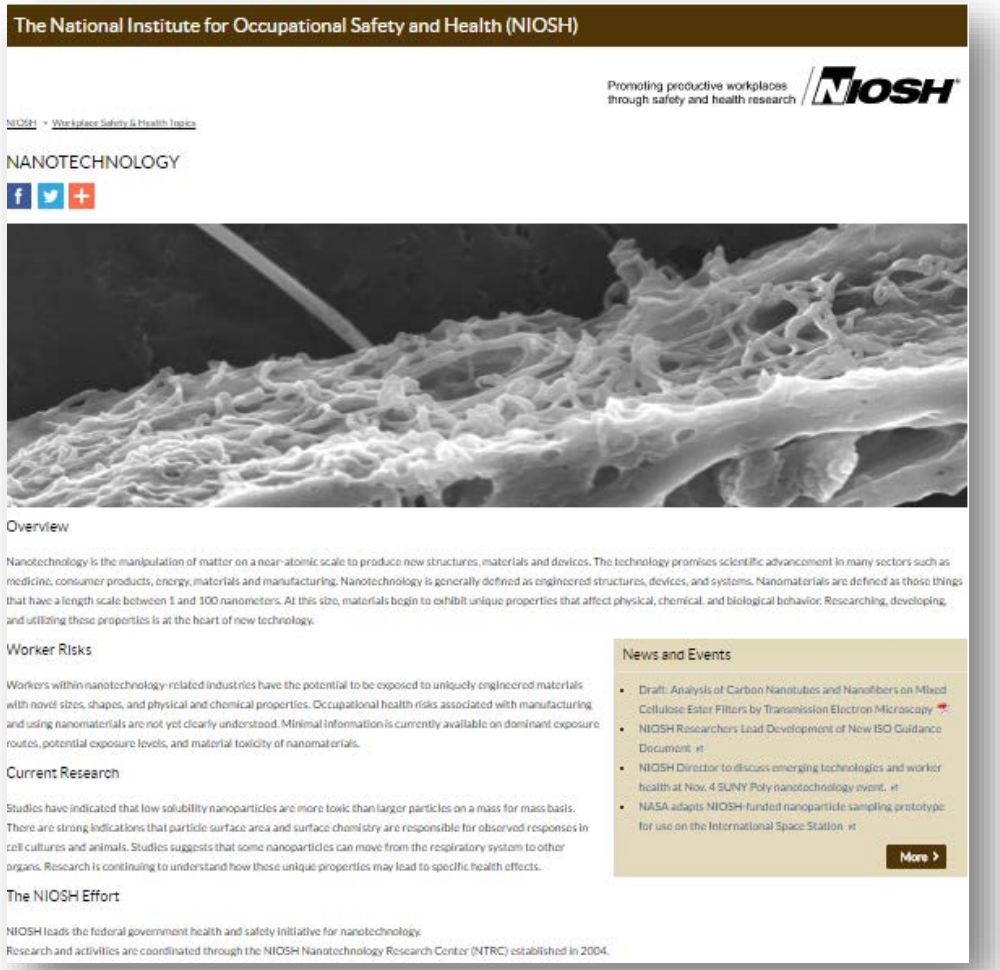
OSHA no tiene una norma o Límite de Exposición Permisible para algun específico nanomaterial, pero hay muchas normas de OSHA existentes, como la norma de respiradores, que aun aplicarían. NIOSH ha establecido los Límites de Exposición Recomendados para nanotubos de carbono y dióxido de titanio de tamaño 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

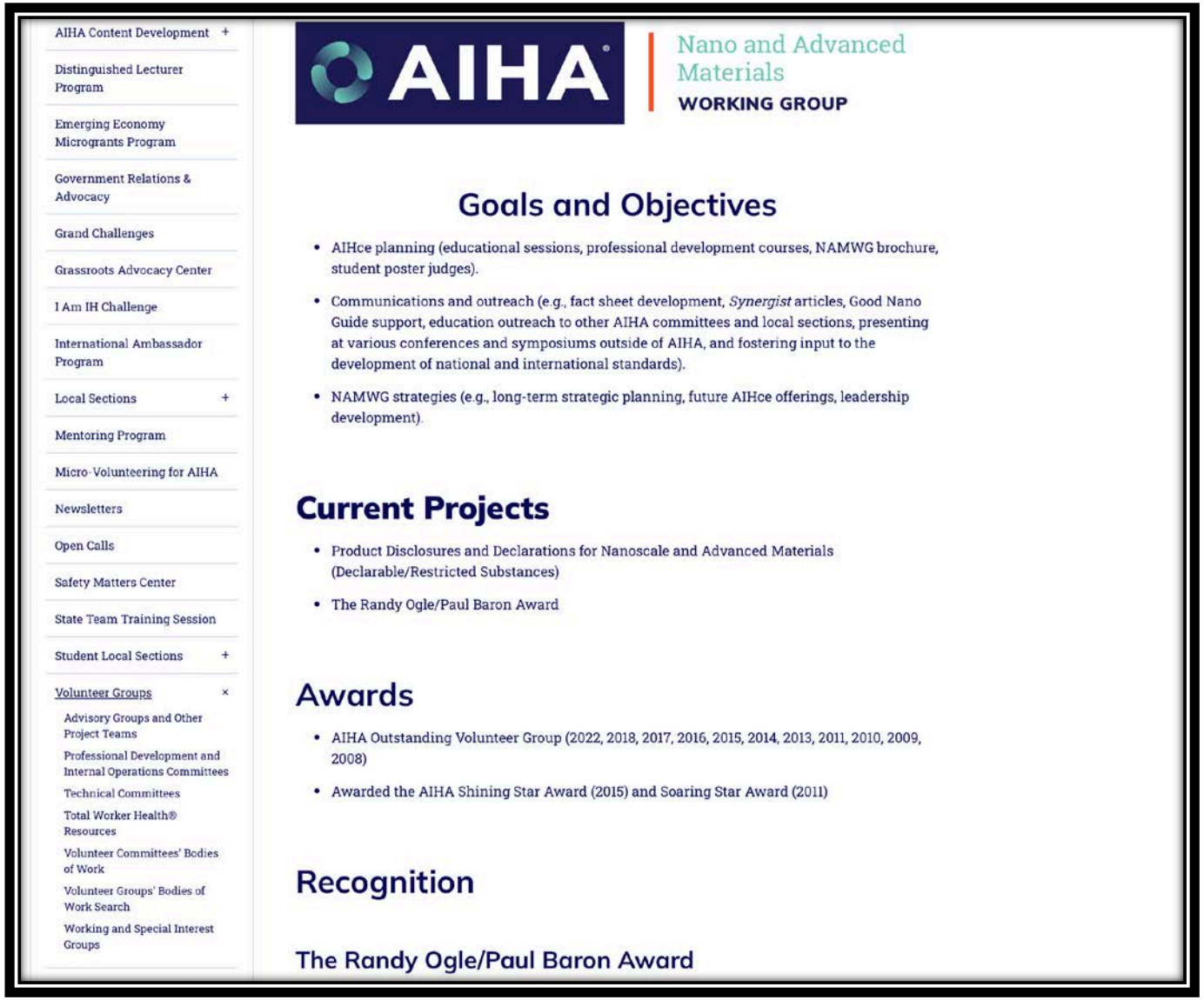
NIOSH's nanotechnology website has useful information on exposures and controls

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



- Recommendations
- Guidance
- News

The AIHA Nano and Advanced Materials Working Group continues promoting Nano H&S



Now a preview of our Nanomaterials Dashboard

William Harris, MS, Research Analyst,
CPWR Data Center

Thanks!
Questions?
Comments?

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