

November 27, 2012

Engineered Nanoparticle Exposures in Construction: Presentation to the ACCSH

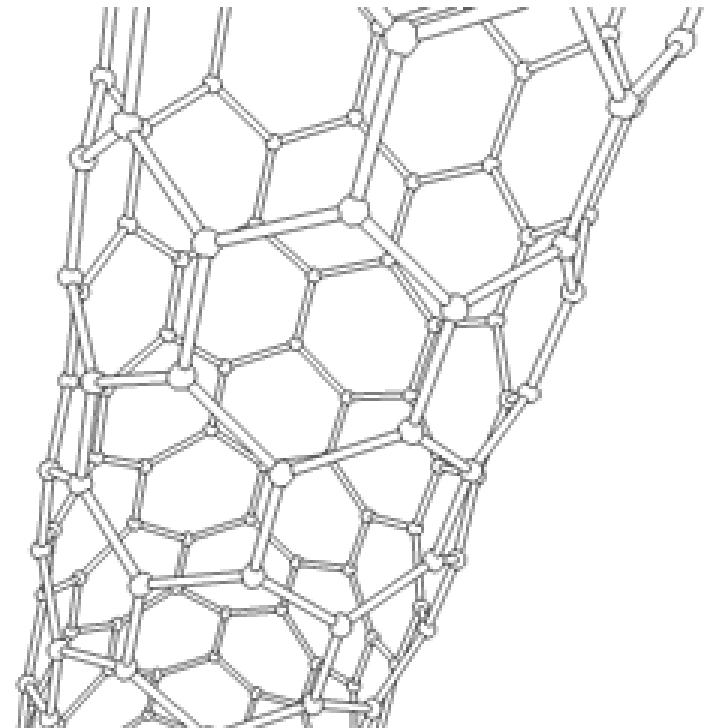
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I would like to address four questions:

1. What nanomaterials are found in construction?
2. What do we know about exposure to nanoparticles in construction?
3. How are the hazards being communicated to workers?
4. What is CPWR planning to do about nanomaterials as the NIOSH-funded National Construction Center?

Question One

What nanomaterials are found in construction?



A recent study
found carbon
nanotubes in the
airborne
particles at
Ground Zero

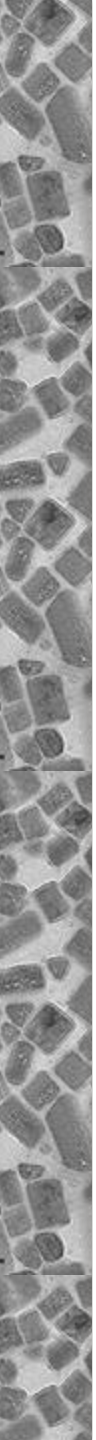
This
presentation
is focused on
engineered
nanoparticles



There are many promising applications in construction, but limited commercialization at this point

ENP	Construction materials	Benefits
Carbon nanotubes	Concrete	Mechanical durability; crack prevention
SiO ₂	Concrete	Reinforcement in mechanical strength
TiO ₂	Cement	Rapid hydration; self-cleaning; pollution reduction
Fe ₂ O ₃	Concrete	Increased compressive strength; abrasion-resistant; stress monitoring
Ag	Coating/painting	Biocidal activity

Lee, Mahendra & Alvarez (2010)



“Cost and the relatively small number of practical applications, for now, hold back much of the prospects for nanotechnology.”

Nanoforum Report: Nanotechnology
and Construction, November 2006

There is more activity in Europe, mostly in coatings, cement and concrete

- 94 available products identified
- reduced weight of concrete with silica fume*
- increased strength and elasticity of concrete
- improved weathering of exterior surfaces
- biocidal surfaces for walls of surgery rooms

* Aggregate of amorphous SiO_2 nanoparticles

These tiles contain nano-titanium
dioxide

BoralPure™

SMOG EATING TILE COLOR COLLECTION



**We would
like to test
exposures**

One roof can oxidize NO_2 from 10,800 miles of driving, according to the manufacturer

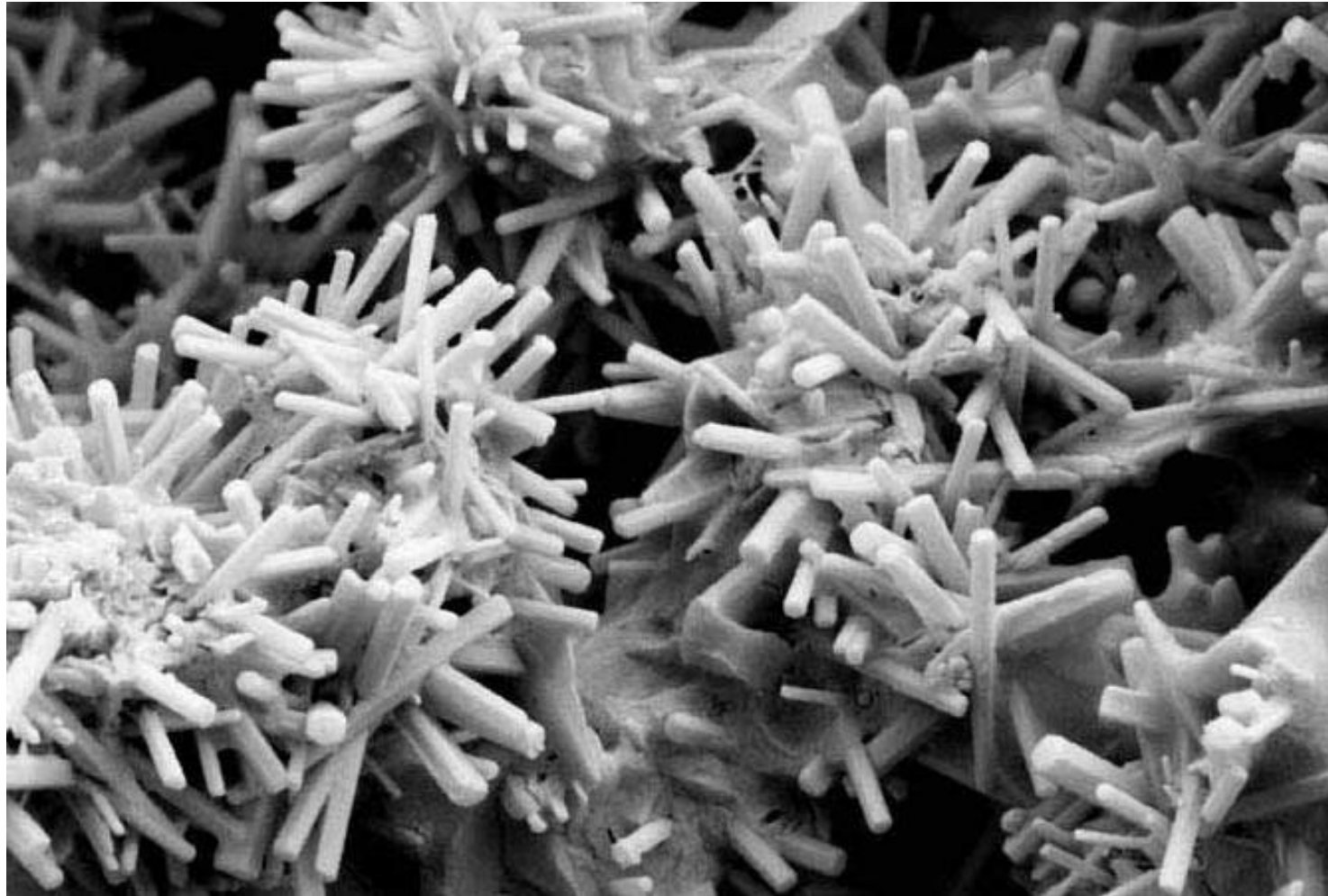




Emaco **Nano**Crete patching compounds
does not contain nanoparticles.

From the manufacturer: “Nanotechnology does NOT mean nano-sized particles: We do not use any nano-particles in our cement formulations.”

These hydrated silicates are *nano-structured*; they have nano-sized holes



NIOSH has begun an HHE looking at Aspen Aerogel insulation, another nanostructured product



Mark Methner,
NIOSH

Question Two

What do we know about exposure to engineered nanoparticles in construction?



Not much!

We know construction workers
may be at risk

**“Inhalation of manufactured
nanomaterials during coating,
molding, compounding, and
incorporation can pose a respiratory
health risk to workers.”**

Lee, J., Mahendra, S. & Alvarez P.J. (2010, July).

We do have corroborating data on ultrafine exposures showing respiratory issues



Apprentice
from UA
Mechanical
Trades School
in Landover,
MD, 9/12

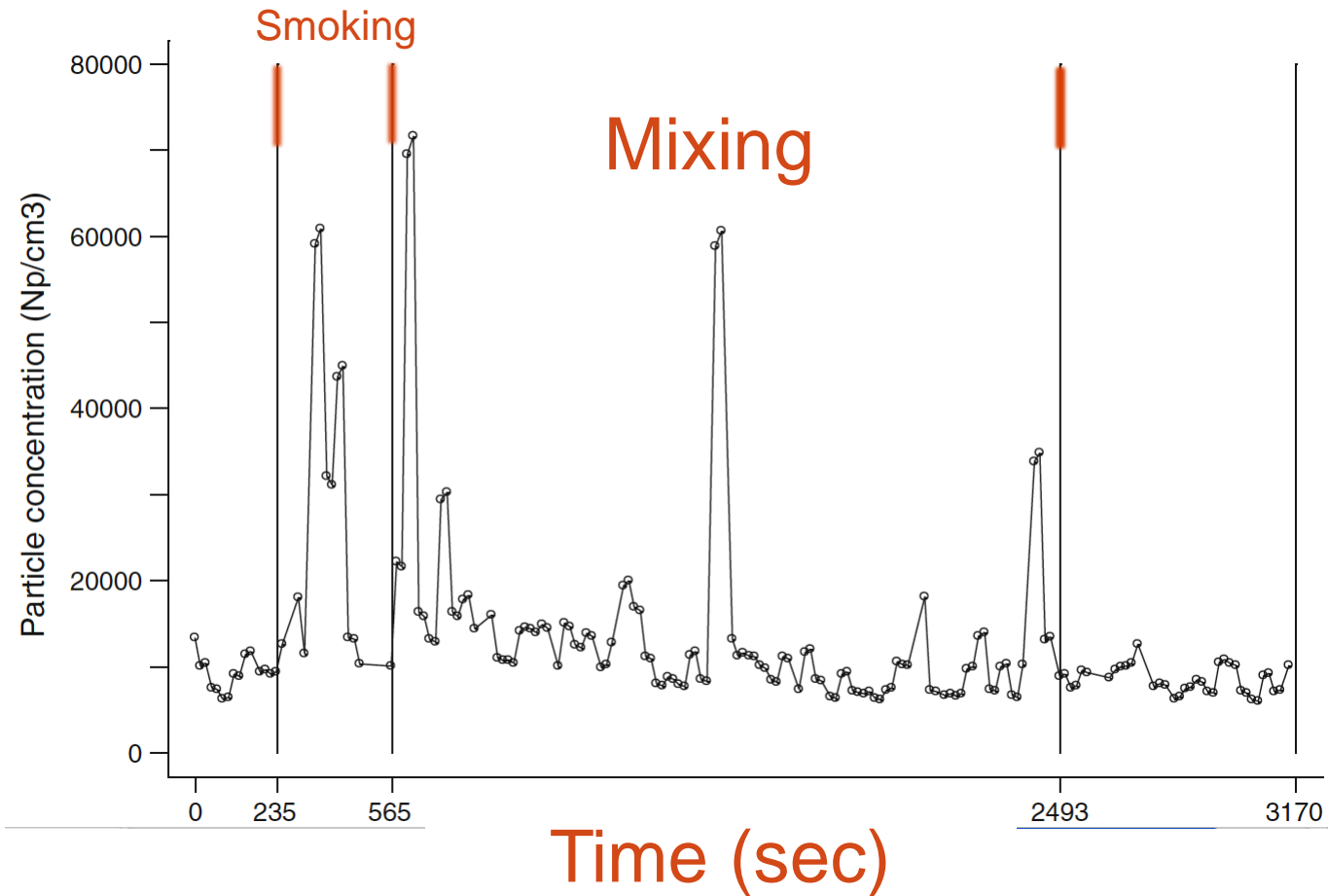
Photo courtesy eLCOSH

Sampling was conducted onsite for several real processes in 2009

(Broekhuizen et al, 2011)

- Mixing Nanocrete mortar
- Applying spray-on TiO_2 coating onto glass

Particle sampling during mixing of 6 bags of Nanocrete mortar (Broekhuizen et al, 2011)

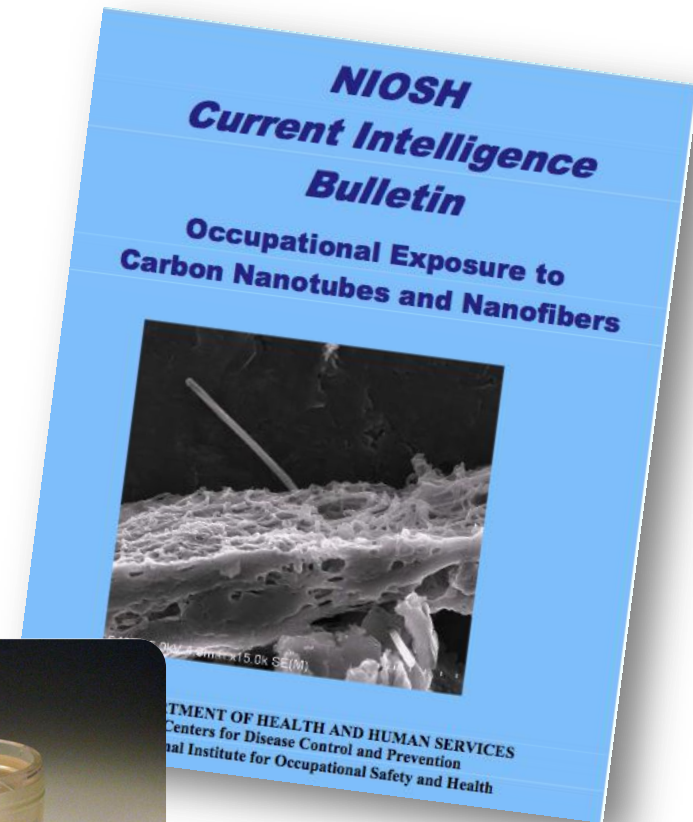


“Workplace measurements suggest a modest exposure of construction workers to nanoparticles (NPs) associated with the use of nanoproducts.”

NIOSH chose mass-based REL over counting with electron microscopy

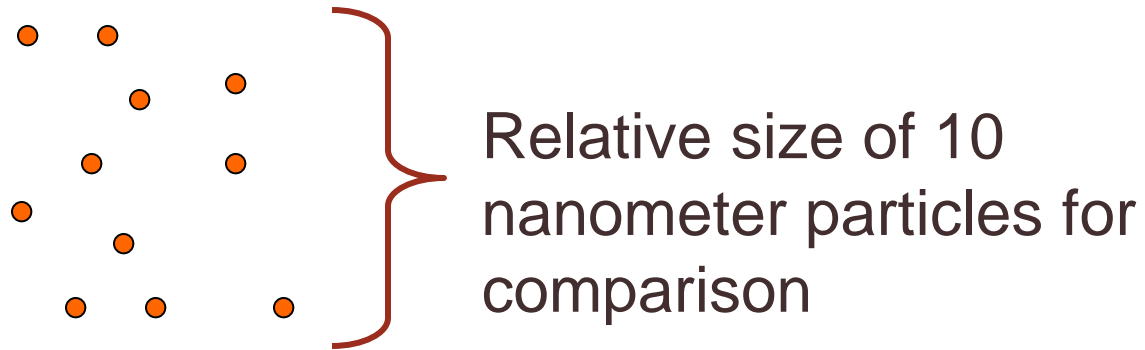
- NIOSH Method 5040
- Counting protocols haven't been developed, although ASTM committee is close

REL of 7 $\mu\text{g}/\text{m}^3$
elemental carbon
(EC) as an 8-hr
TWA



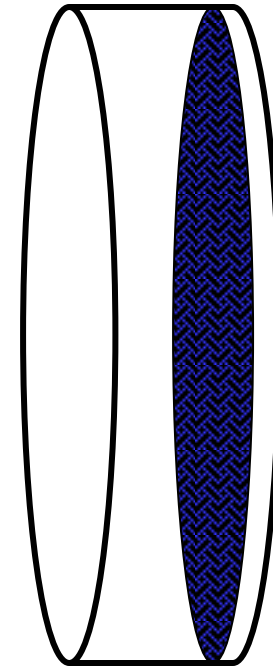
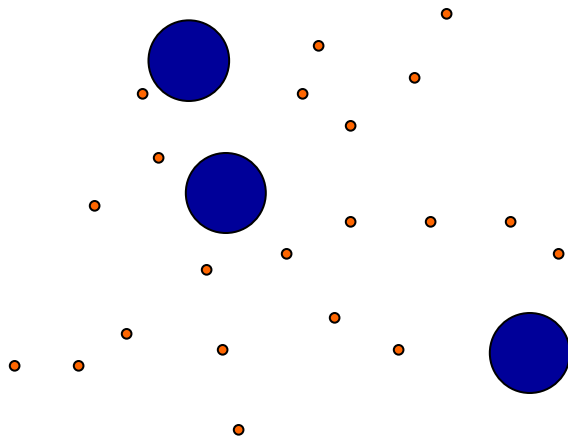
Nanoparticles Have Almost No Mass

← Edge of a single 10 micron particle



A 10 μm particle weighs the same as one billion 10 nm particles

Large particles bias mass measurements

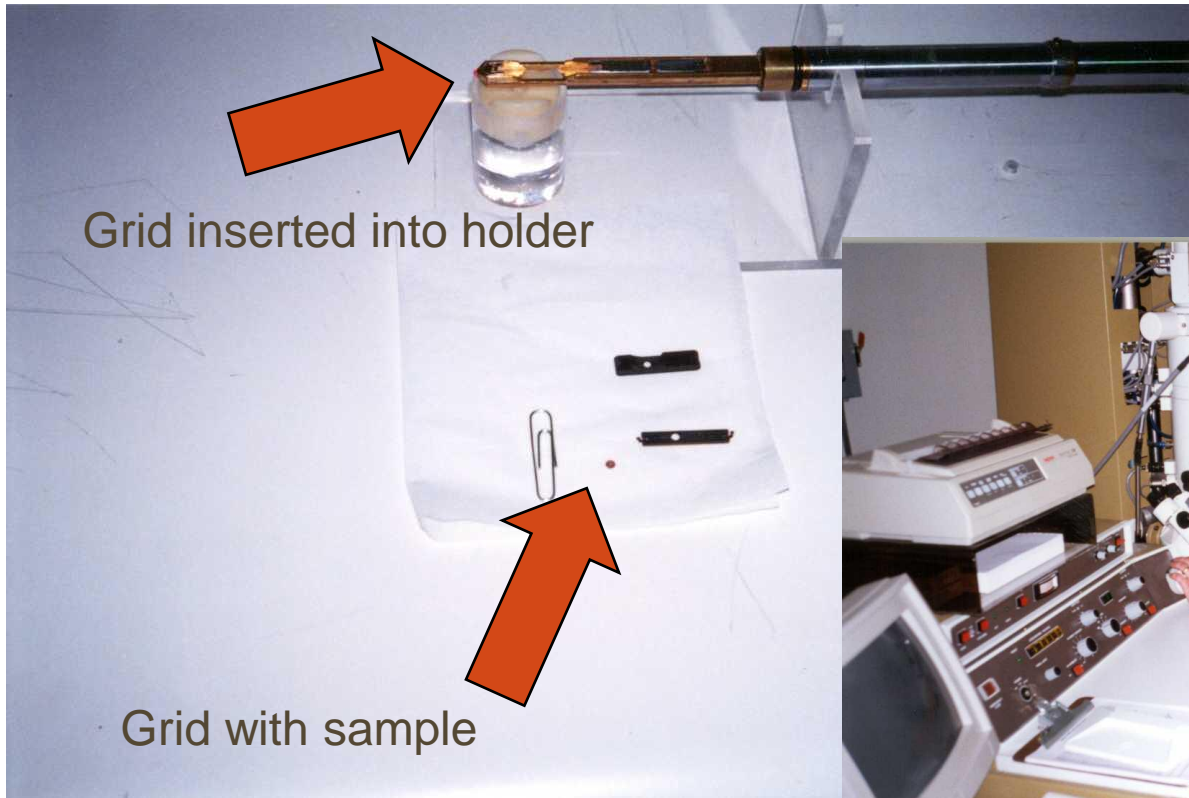


Standard
37-mm filter
cassette

If you're carrying a grocery bag full of cantaloupes,
you're not going to notice a handful of grapes

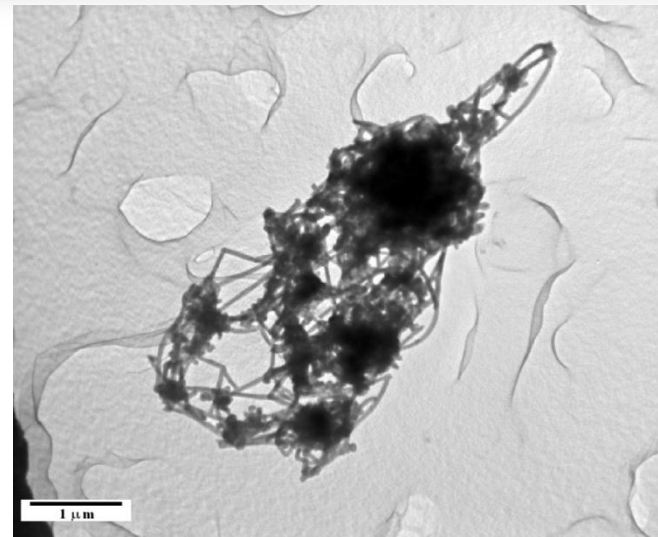
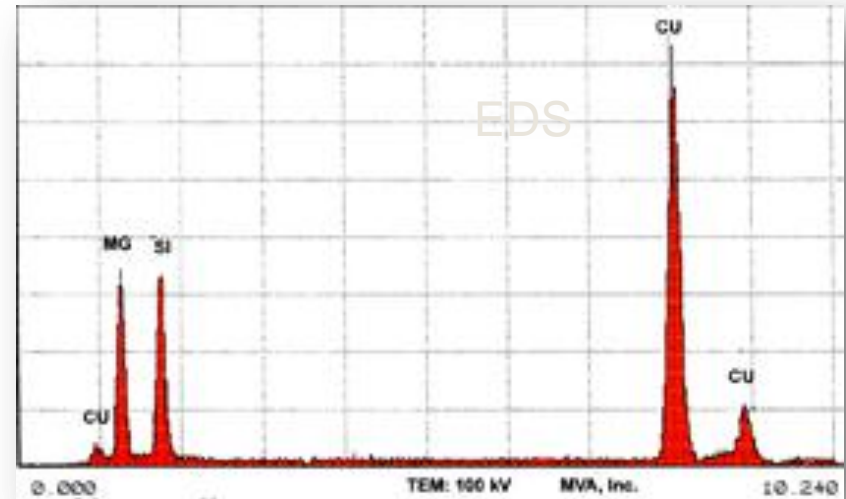
Courtesy L. Gibbs

Transmission electron microscopy is the gold standard and will be used in CPWR's work



TEM allows several measurements

- Shape
- Chemical composition
- Particle count
- Particle length and diameter

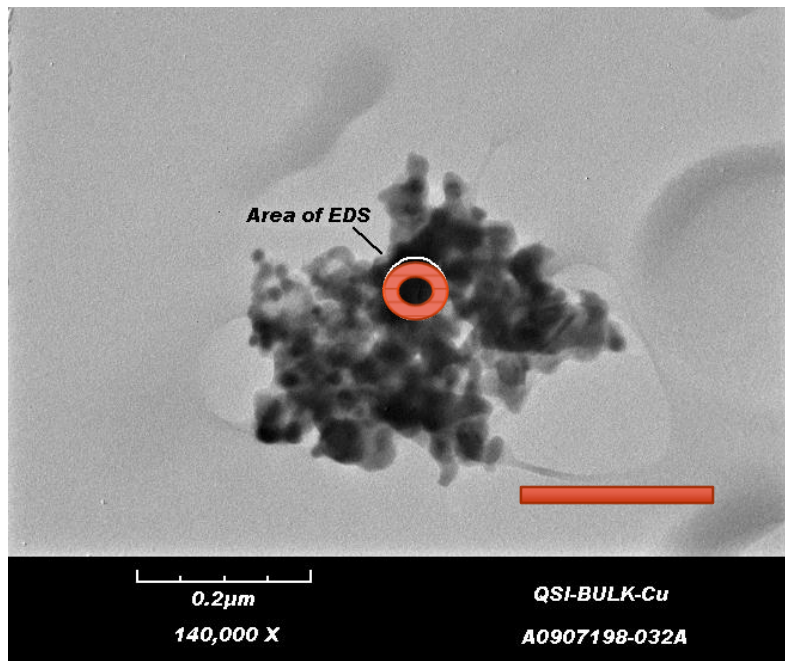


NIOSH image of MWCNT

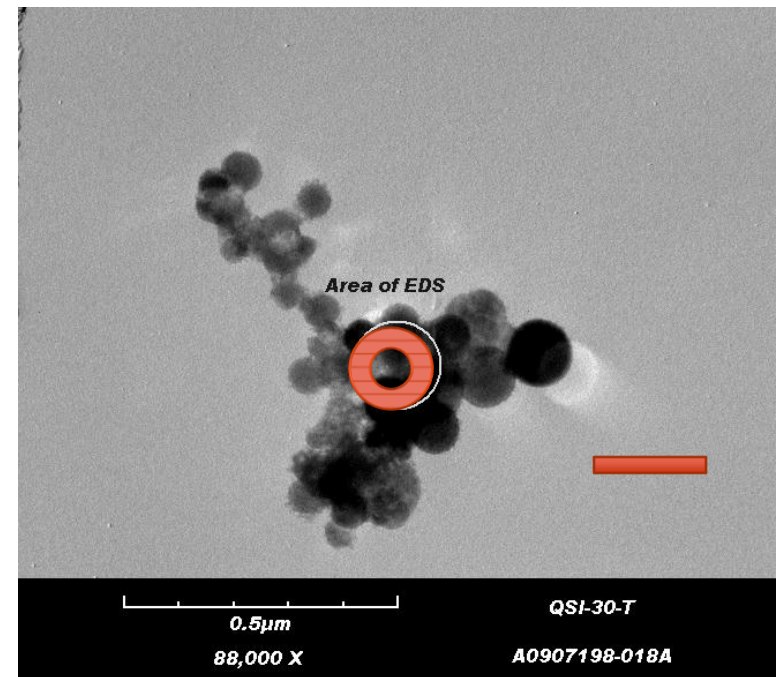
You do the analysis: Do these particles appear similar?

Yes

No



Bulk product sample



Air sample

Question Three

How are the hazards being communicated to workers?



Photo courtesy
eLCOSH

“80% of the workers’ reps and 71% of the employers’ representatives were not aware of the availability of nanomaterials and were ignorant as to whether they actually use nanomaterials at their workplace.”

2009 Survey response from 28 construction workers and employers in Europe (N = 144)

Broekhuizen et al. 2011

We haven't been doing a great job communicating the hazards of *standard* industrial chemicals

Hazard Communication: A Review of the Science Underpinning the Art of Communication for Health and Safety
Sattler, Lippy & Jordan, May, 1997

Sattler, Lippy & Jordan | 1997 review of hazcom literature for OSHA was the only one for a decade

- University of Maryland contract with OSHA. Report at: www.osha.gov
- Accuracy of technical information was a problem
- Most studies were based on reported preferences, not behaviors
- Populations studied were students not workers

Comprehensibility of MSDSs was not good

Literate workers only understood **60%** of the health and safety information on sample MSDSs in **three different comprehensibility studies:**

- Printing Industries of America, 1990
- Kolp, Sattler, Blayney, Sherwood, 1993. Am. J. Ind. Med
- Phillips, 1998

Findings from a newer review of the literature did not show improvements

Category	Findings
Accuracy and completeness	“Relatively poor”
Awareness and use	“Suboptimal in workplaces studied”
Comprehensibility	“Poor presentation and complex language...low comprehensibility”

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

Lippy Group reviewed NIOSH collection of nano MSDSs

- **N = 49 MSDSs**
- **Reviewed all of the MSDSs**
- **33% did NOT identify the nano component**
- **52% did NOT have any cautionary language**
 - Large surface area in relation to particle size enhance physical and chemical properties (nanosilver)

Most (62%) just referenced PELs and TLVs for the macro size

- **32% percent indicated nothing**
- **Only 6% used cautionary language about using PELs/TLVs**

MSDS for Carbon Nanotube

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	%
Synthetic graphite	Up to 100%

OSHA/PEL
15 mg/m³ (total dust)
5 mg/m³ (respirable fraction)

ACGIH/TLV
2 mg/m³ TWA

The GHS changes will be a big improvement, but OSHA can do more using the existing SDS format

- **ANSI Section 16 “*Other Information*” is the key.**
- **Useful risk information about nanoparticles can be included in Section 16.**
- **OSHA could create an eTool helping SDS developers with the appropriate language**

Question Four

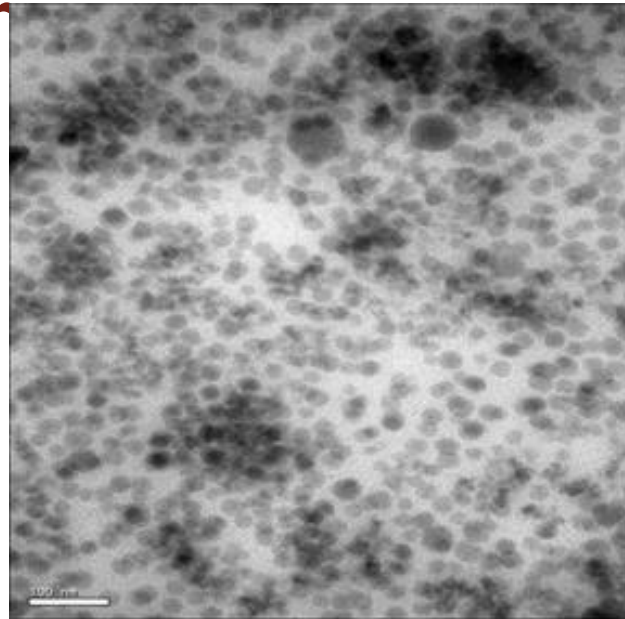
What is CPWR planning to do about nanomaterials as the NIOSH-funded National Construction Center?



THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

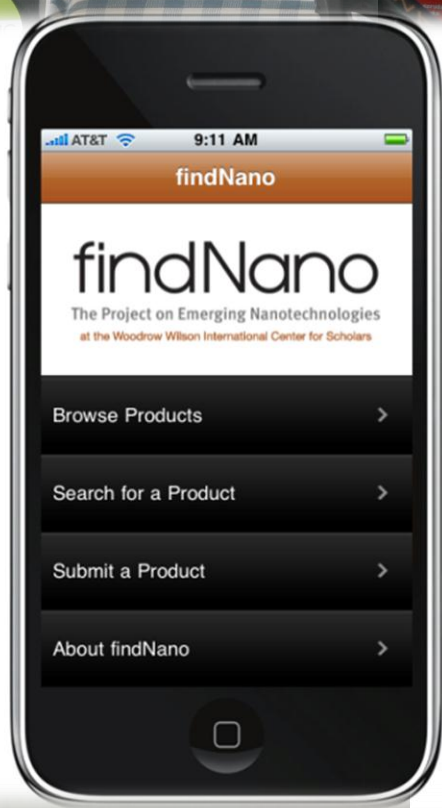
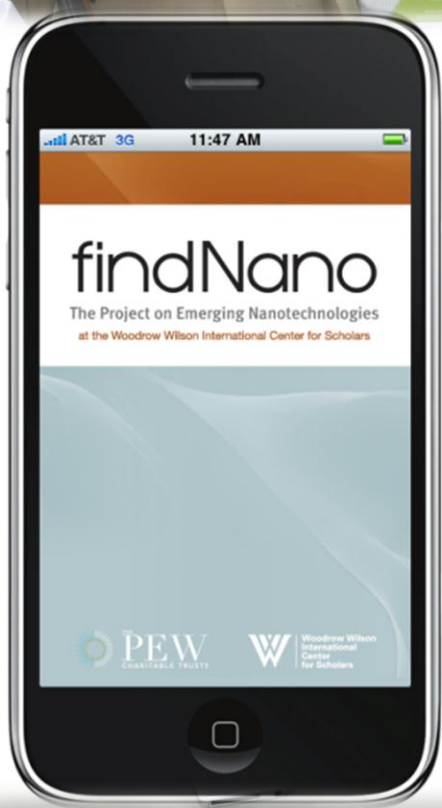
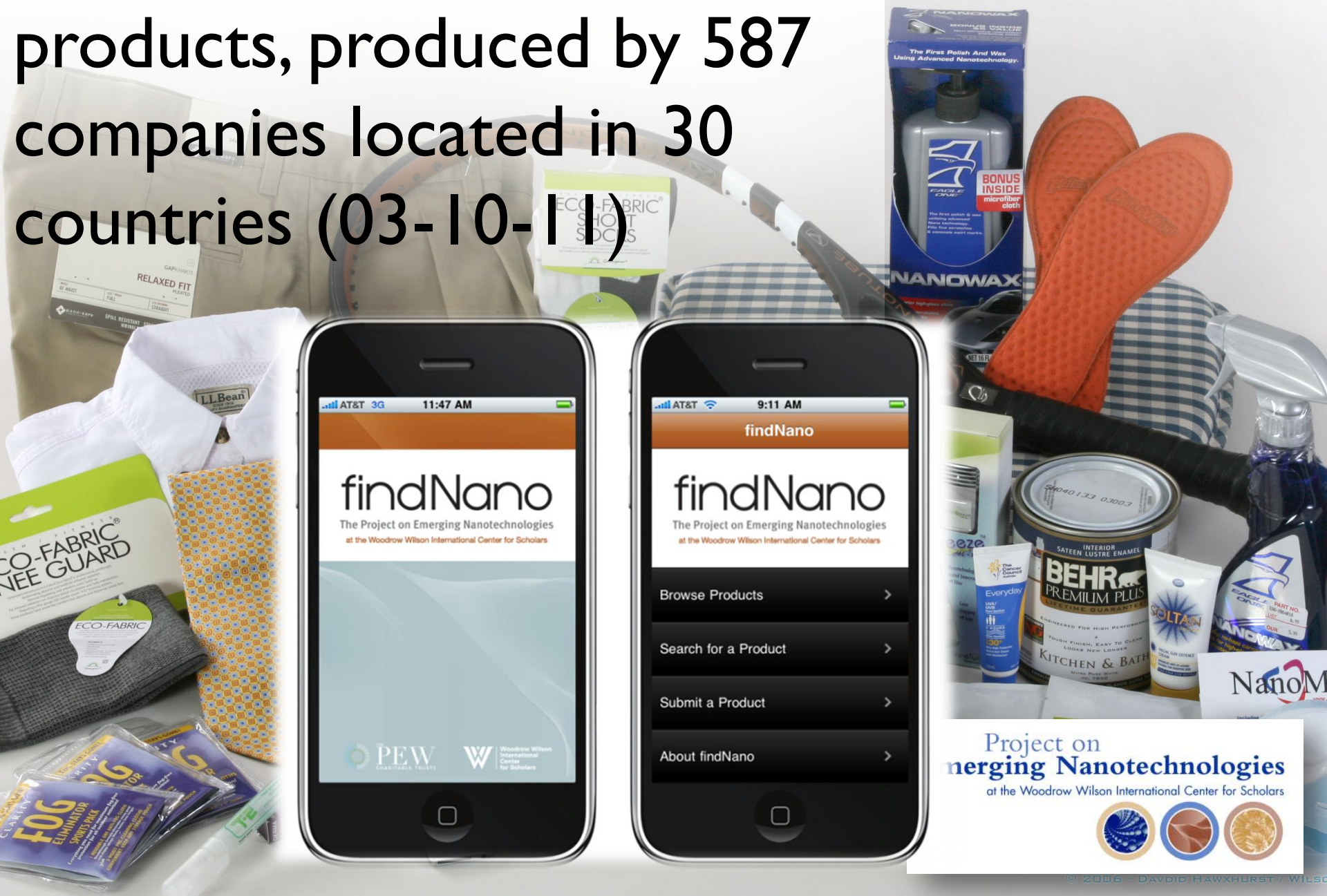
Two CPWR Initiatives

- I. Identify specific construction-related products and create an inventor




Nano-phase silica-filled epoxy adhesive
SEM image (scale bar = 100 nm)

Wilson Center has 1317 products, produced by 587 companies located in 30 countries (03-10-11)



Project on
emerging Nanotechnologies
at the Woodrow Wilson International Center for Scholars



The Europeans have created an inventory of construction products

- FIEC represents construction employer organizations in 29 countries
- EFBWW represents 75 affiliated construction unions in 31 countries and represents a total of 2,350,000 members

Search:

[Submit](#)

Developed and maintained by CPWR - The Center for Construction Research and Training.

Hazards



Trades



What's New

CPSC, Ryobi Portable Table-Saws Recalled Due to Laceration Hazard

CPWR Technical Report: Risk of Isocyanate Exposure in the Construction Industry

Fatal and Nonfatal Injuries among Hispanic Construction Workers 1992-2008

[All](#)

Jobsites



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Newly revised site for nano!

Join us 

[Related Links](#)

Check out CPWR's [Construction Solutions](#)

Second CPWR Initiative

1. Identify specific construction-related products and create a registry
2. Identify applicable control technologies currently in the CPWR Construction Solutions database and measure their effectiveness with nanoparticles

Will these control nanoparticles in construction?

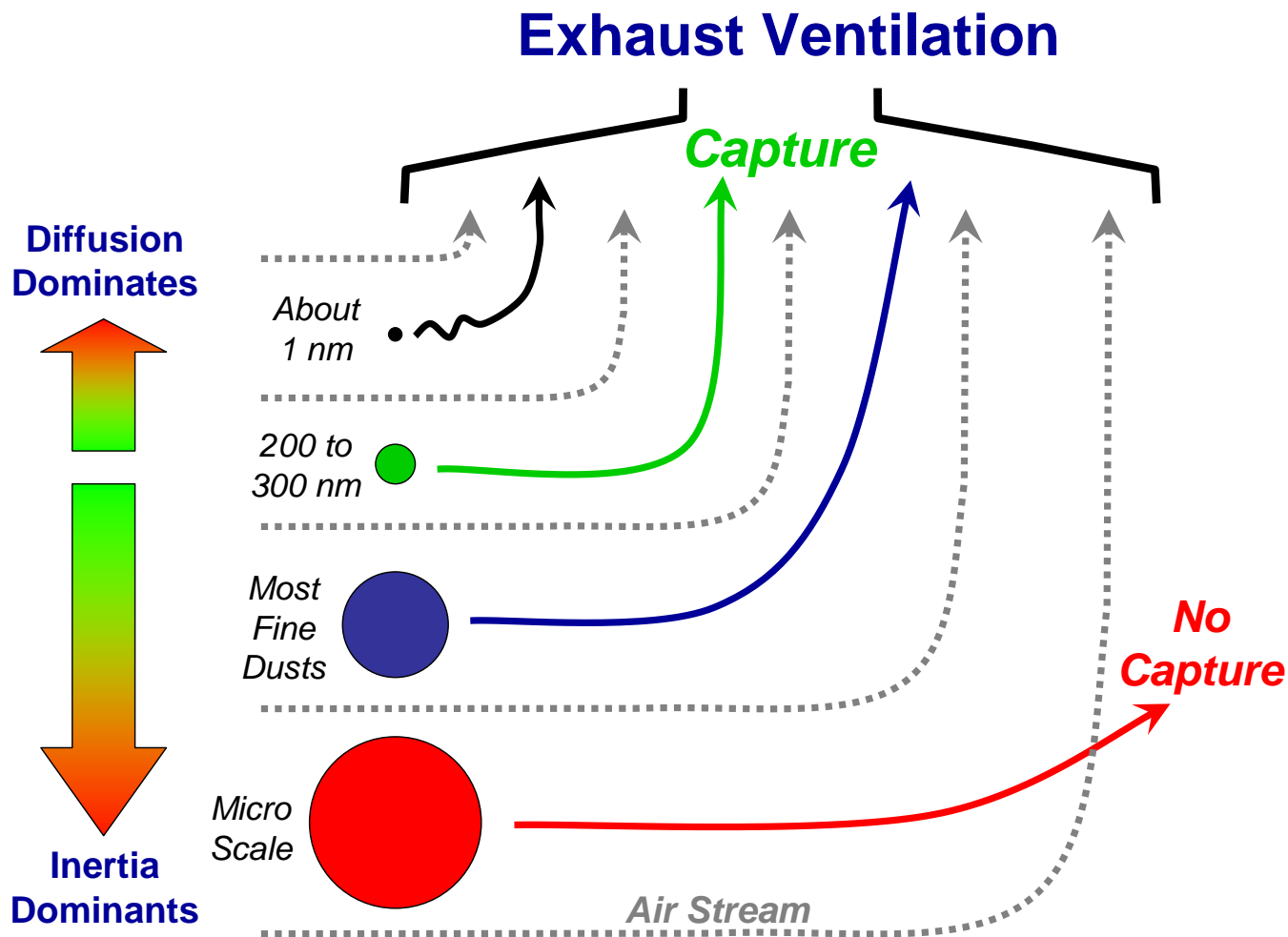


Airtec Jet-Rotary Hand-Held Concrete Milling Machines



Pentek Air-Powered COMPACT-VAC High Performance HEPA Vacuum

Conventional controls should work with nano



CPWR will be working with a firm called EPI Services that has a test chamber



Controlled area where construction products will be tested.
Photo courtesy EPI Services, Inc.

Along with its own website and distribution system, CPWR will work with other organizations including yours

The screenshot shows the GoodNanoGuide website. At the top is a blue header with the GoodNanoGuide logo. Below the header are three images: a hand using a pipette, two people in a lab setting, and a woman wearing safety glasses. The main content area includes a search bar with a 'Go' button, a 'Beta Sponsors' section with logos for ICON International Council on Nanotechnology, NanoTech BC, nanoAlberta, Industry Canada, Industrie Canada, nano québec, and IIRST, and a 'My Tools' section with a 'My Preferences' link. On the right, there is a 'Welcome to the GoodNanoGuide' section with a paragraph of text and three interactive buttons: 'New to nanotechnology?', 'Know about nanotechnology?', and 'Expert in workplace practices?'. Each button has a description of the user's goal and a 'Start Here' button.

Search

Go

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My Tools
My Preferences

Welcome to the GoodNanoGuide
The GoodNanoGuide is a collaboration platform designed to enhance the ability of experts to exchange ideas on how best to handle nanomaterials in an occupational setting. It is meant to be an interactive forum that fills the need for up-to-date information about current good workplace practices, highlighting new practices as they develop.

New to nanotechnology?
Want to know about efforts to develop good workplace practices for nanomaterials?
Basic
Start Here

Know about nanotechnology?
Want to know more about good workplace practices for handling nanomaterials?
Intermediate
Start Here

Expert in workplace practices?
Want to know more about similar good practices for handling nanomaterials?
Advanced
Start Here

<http://GoodNanoGuide.org>

NIOSH

Questions?

for more info contact:

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