Construction Workers and Nanomaterials: Perspective of Vulnerable and Unique Stakeholders

Session D: Emerging Techologies and Advanced Materials

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CPWR

THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Early Nanotechnologists

Lycurgus Cup

http://www.britishmuseum.org/explore/highlights/highlight_objects/pe_mla/t/the_lycurgus_cup.aspx

CPWR is a U.S. nonprofit that conducts research into construction health and safety (www.cpwr.com)

My comments are my own and not those of NIOSH, the source of our nanotechnology research funding

Emerging technologies and advanced materials bring to mind:

Center for Nanophase Materials Science, Oak Ridge, TN

But not construction!

Here are the questions I'd like to tackle:

1. Why are construction workers particularly vulnerable stakeholders?
2. What can we say about construction workers' exposure to engineered nanomaterials?
3. What are we doing to understand the hazard posed by construction nanomaterials?
4. How are we doing communicating risk to construction workers?

Why are construction workers particularly vulnerable stakeholders?

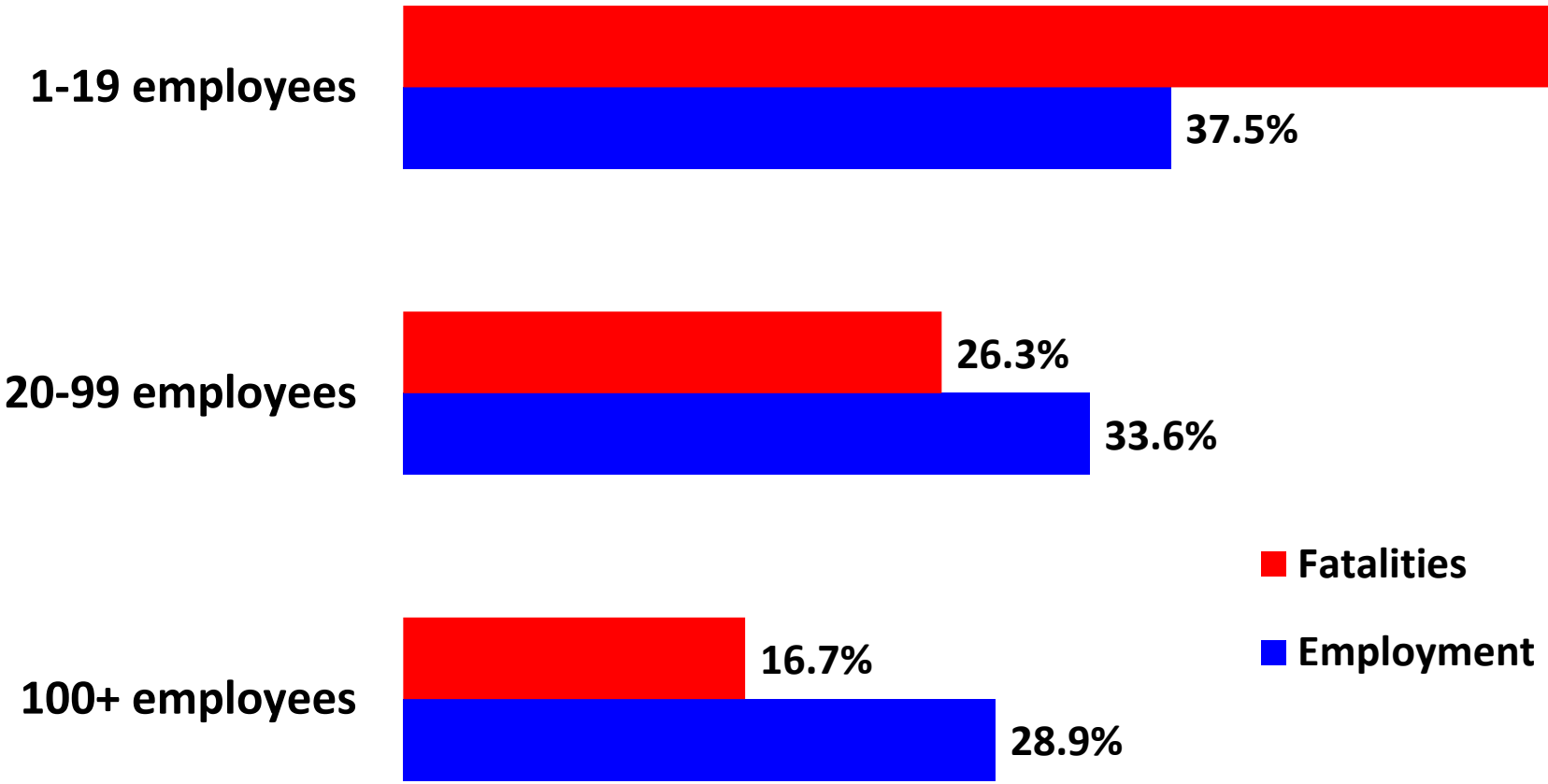
Question 1

Construction is dominated by small employers and a diverse workforce

- 90% have <20 employees
- About 80% have <10 employees
- 30% of workers are Hispanic
- 14% are employed by temp agencies

Sources: U.S Census Bureau; CPWR Construction Chart Book 5th Edition; CPWR 2nd Quarter 2015 Quarterly Data Report

Small firms represent a disproportionate percentage of construction fatalities (2015)



CPWR The Construction Chart Book 2018


Materials represent the largest expense category for construction
U.S. Census Bureau. 2007 Economic Census, Construction Subject Series

In 2010, more than half of U.S. construction workers reported exposure to vapors, gas, dust or fumes twice a week or more

Liss GM, Petsonk EL, Linch KD [2010, Nov]. The construction industry. In: Occupational and Environmental Lung Diseases

Bystander exposures can be significant in construction

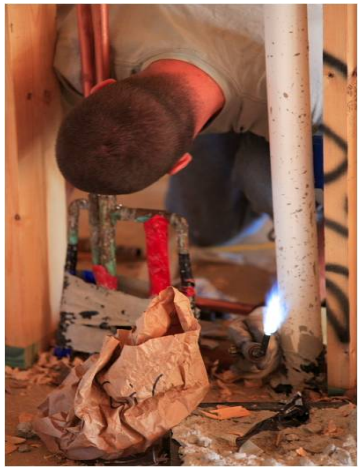
Photo courtesy of the NJ Department of Health and Senior Services' NIOSH-funded Silicosis Surveillance Project

Providing useful information will be difficult over the life cycle of construction

Production

Installation

Maintenance



Recycling/
Demolition/

Nanomaterials may extend building life by decades

ENMs are being used in high volume materials

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

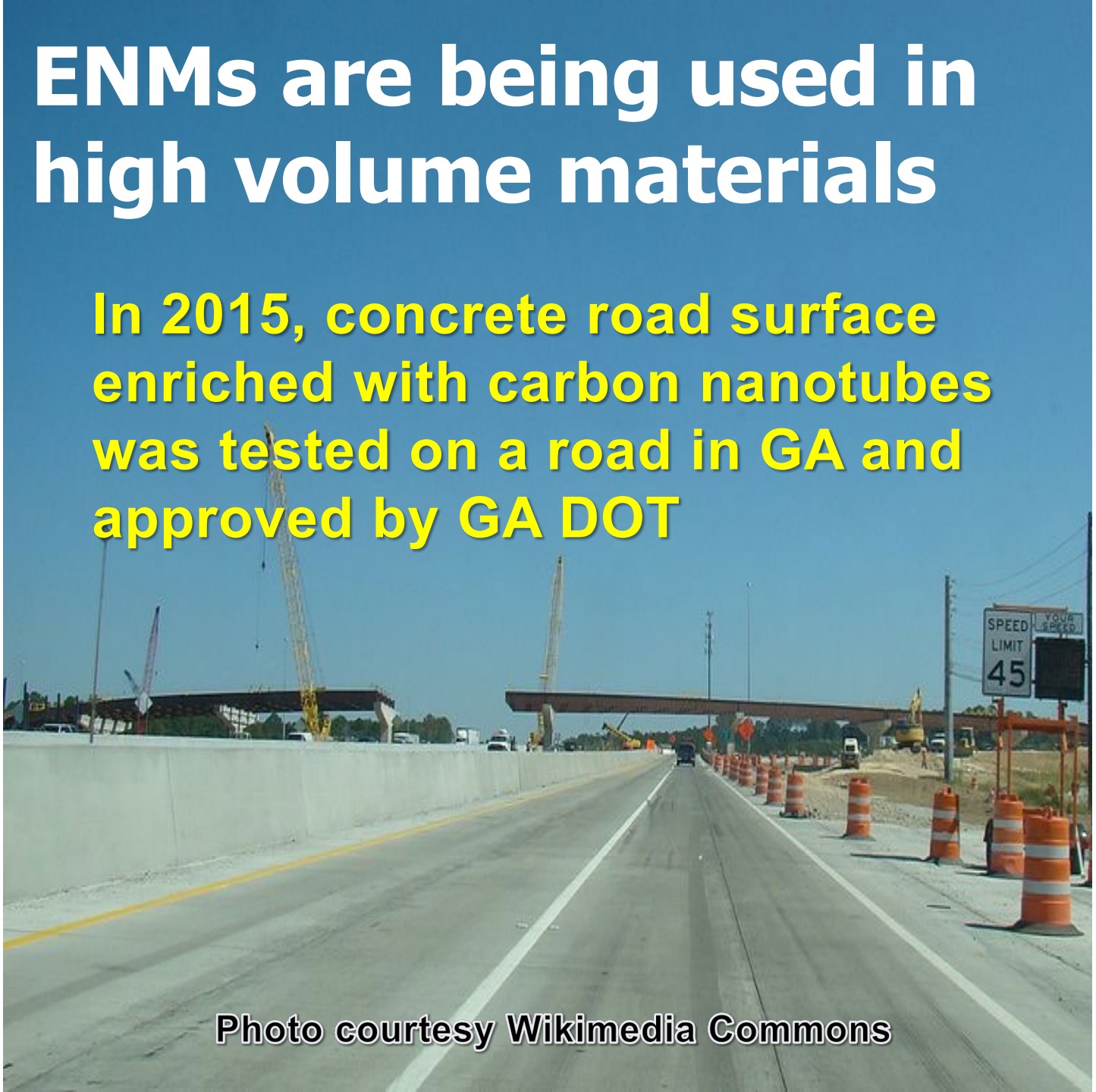
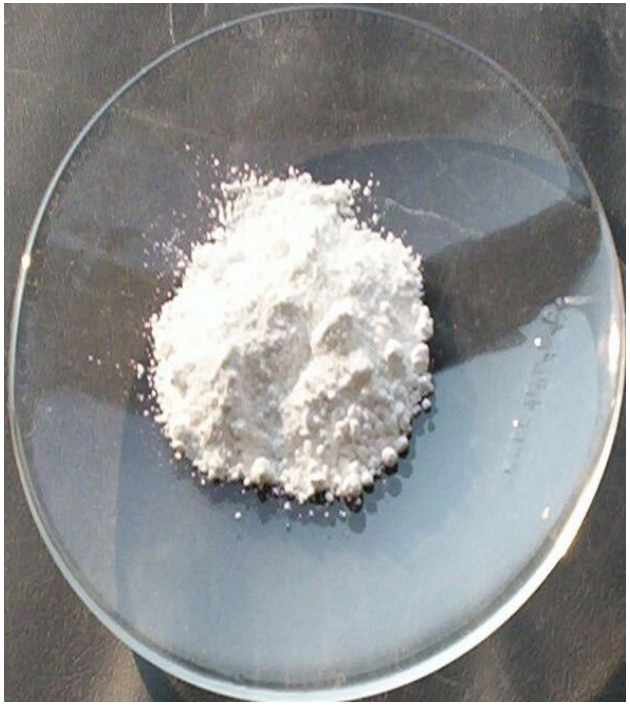


Photo courtesy Wikimedia Commons

Toxicology studies have focused on raw ENMs



Photos courtesy
Wikimedia Commons

Not on mixed construction dust

What can we say about construction workers' exposure to engineered nanomaterials?

Question 2

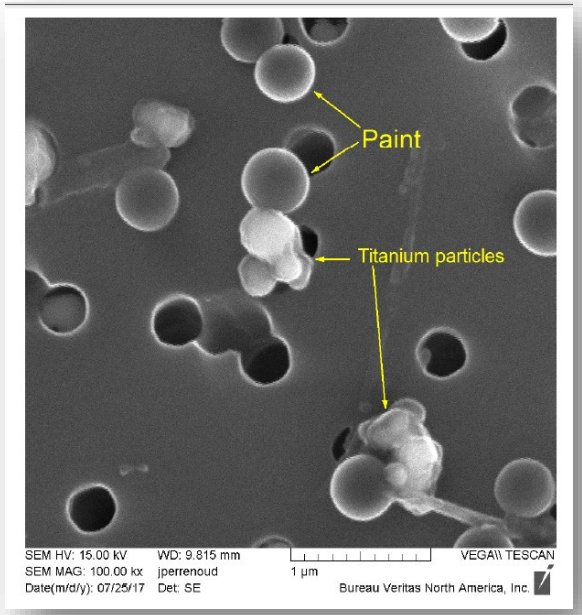
1 2

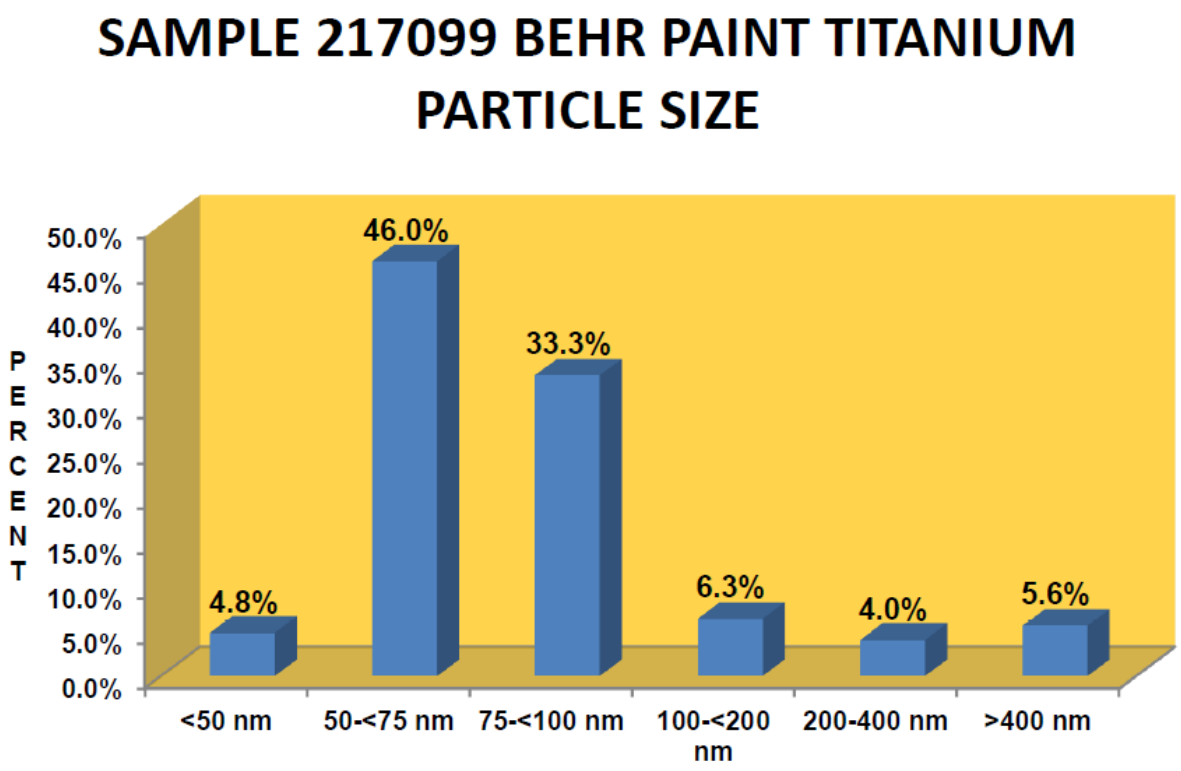
Multiple studies have evaluated release of NOAA from coatings during sanding

(Dylla and Hassan, 2012; Vaquero, Gelarza and Ipina, 2015; West et al. 2016)

Results are mostly encouraging with regard to worker health.

April 2017, we sampled exposures during spraying paint containing nano titanium dioxide, with subsequent sanding





We used the same 3-pronged sampling approach

Photo courtesy Earl Dotter

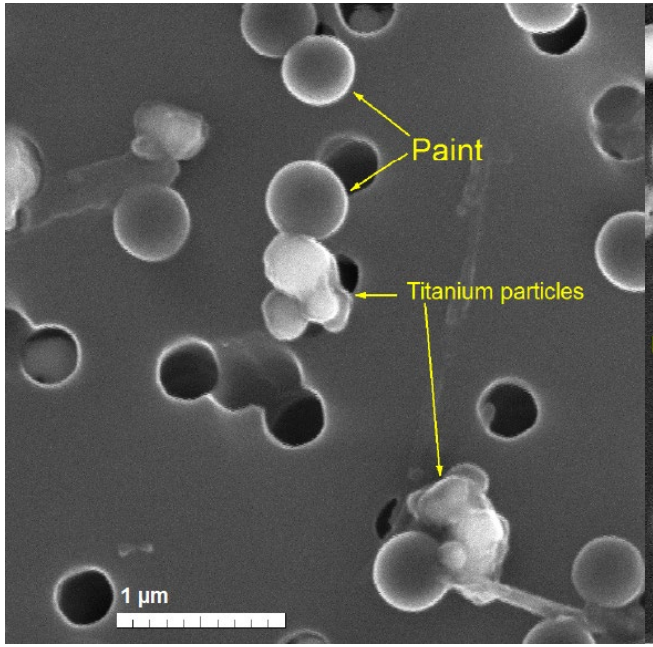
Prong 1: Real-time instruments

TSI Scanning Mobility Particle Sizer and Optical Particle Sizer

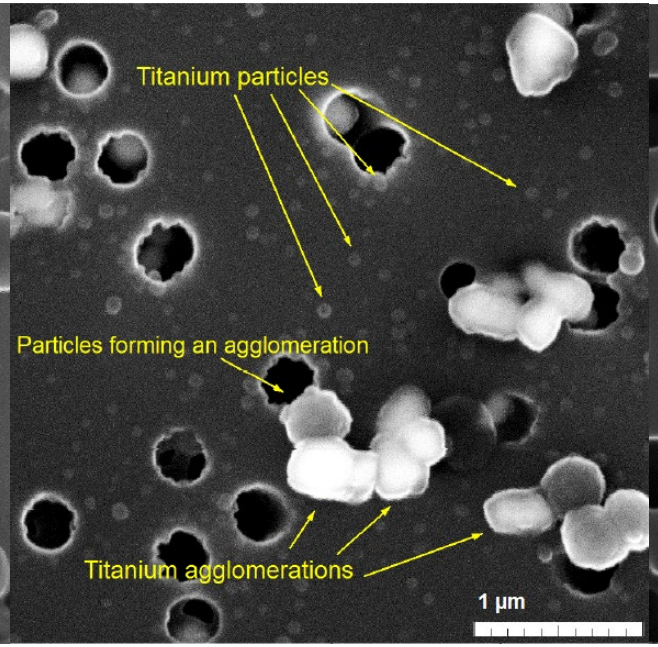
Prong 2: standard industrial hygiene sampling for dust and metals

Photos courtesy Earl Dotter

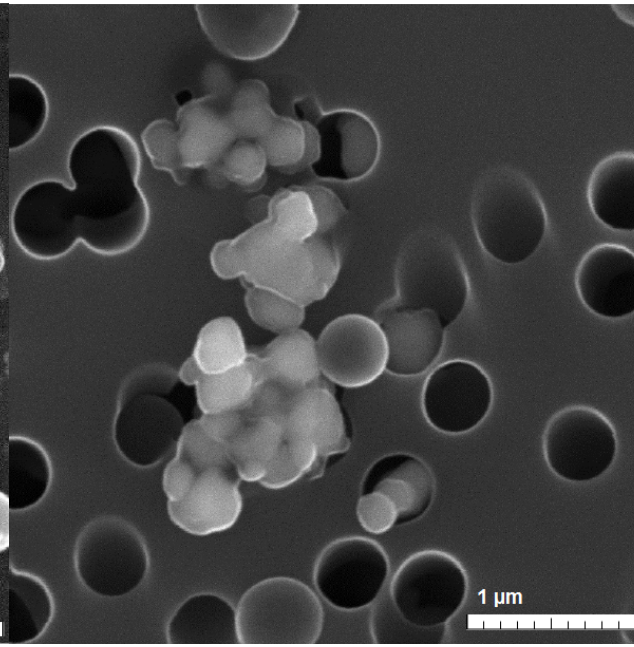
Prong 3: electron microscopy of bulk and airborne particles



Sonicated in water



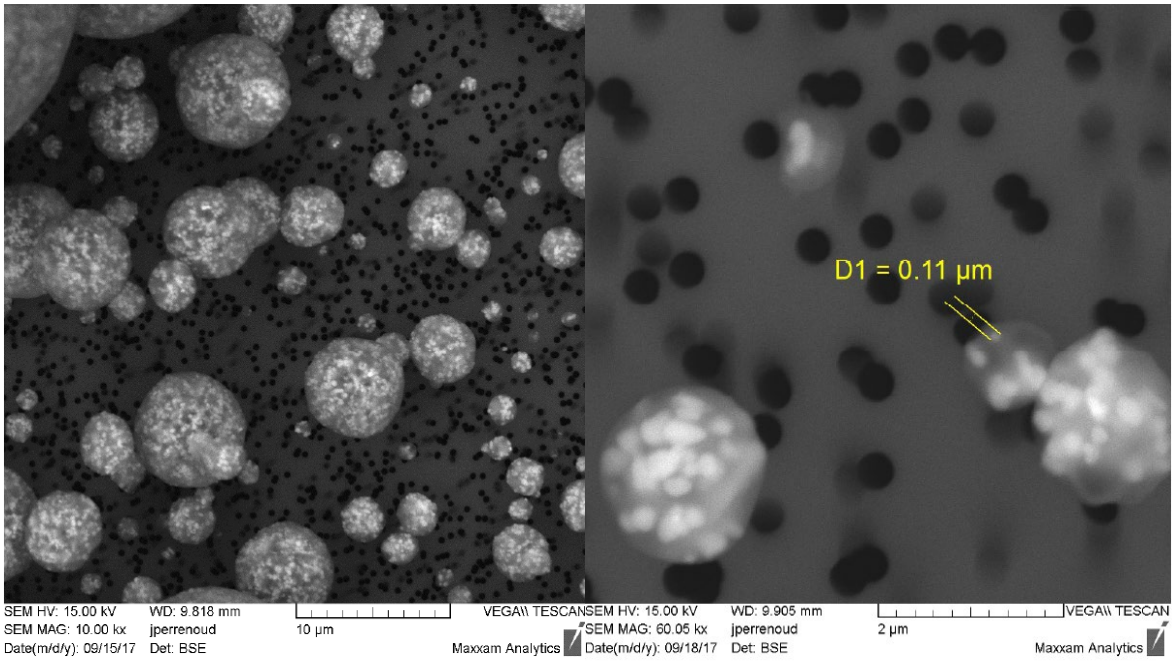
Sonicated in acetone

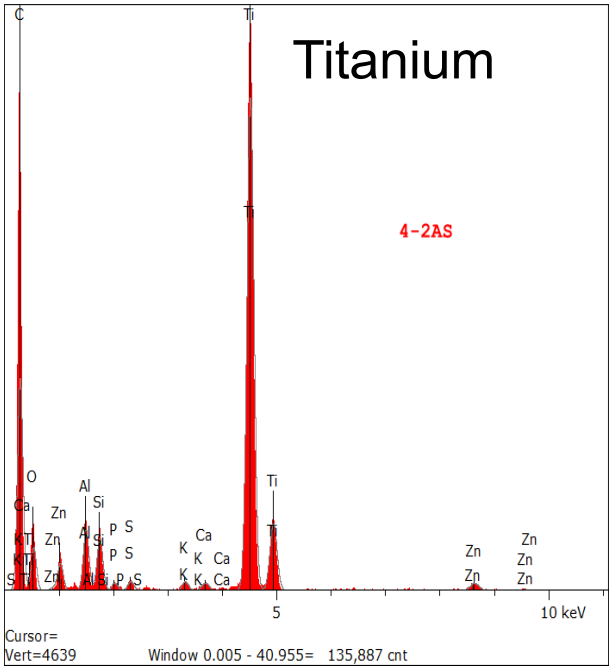


Conventional paint in acetone

SEM bulk characterization of paint

SEM images and EDS spectra of airborne particles from spraying

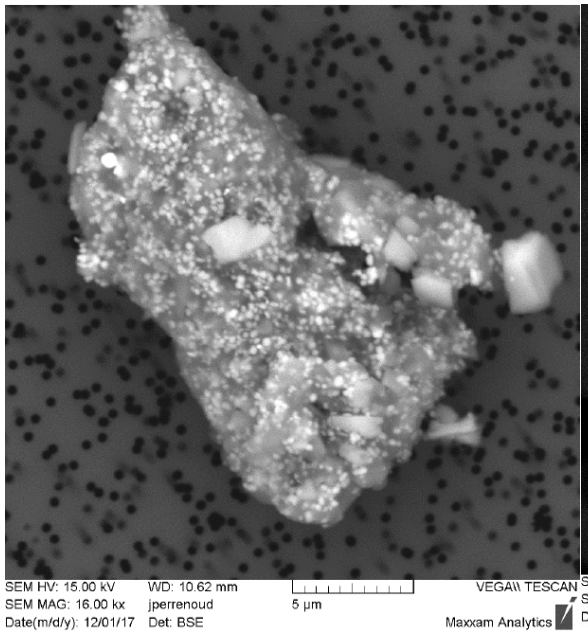




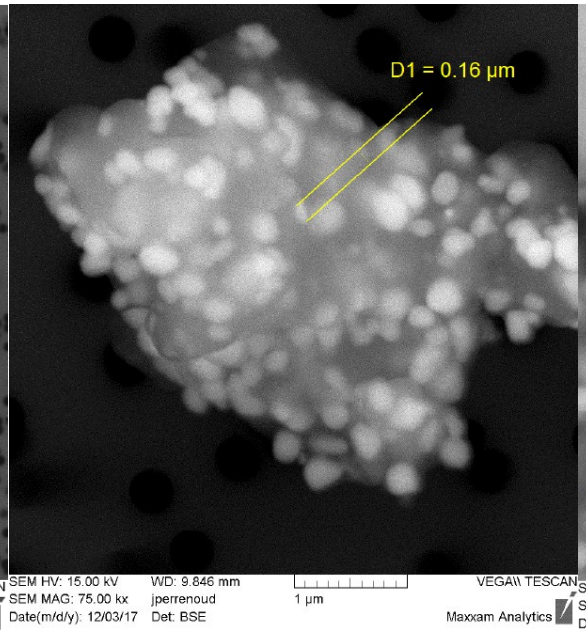
10,000 x

20,000 x

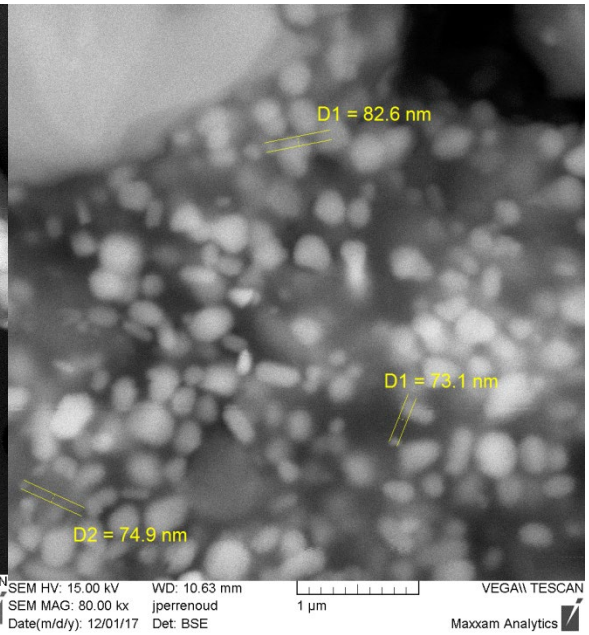
SEM images of airborne particles from sanding



16,000 x

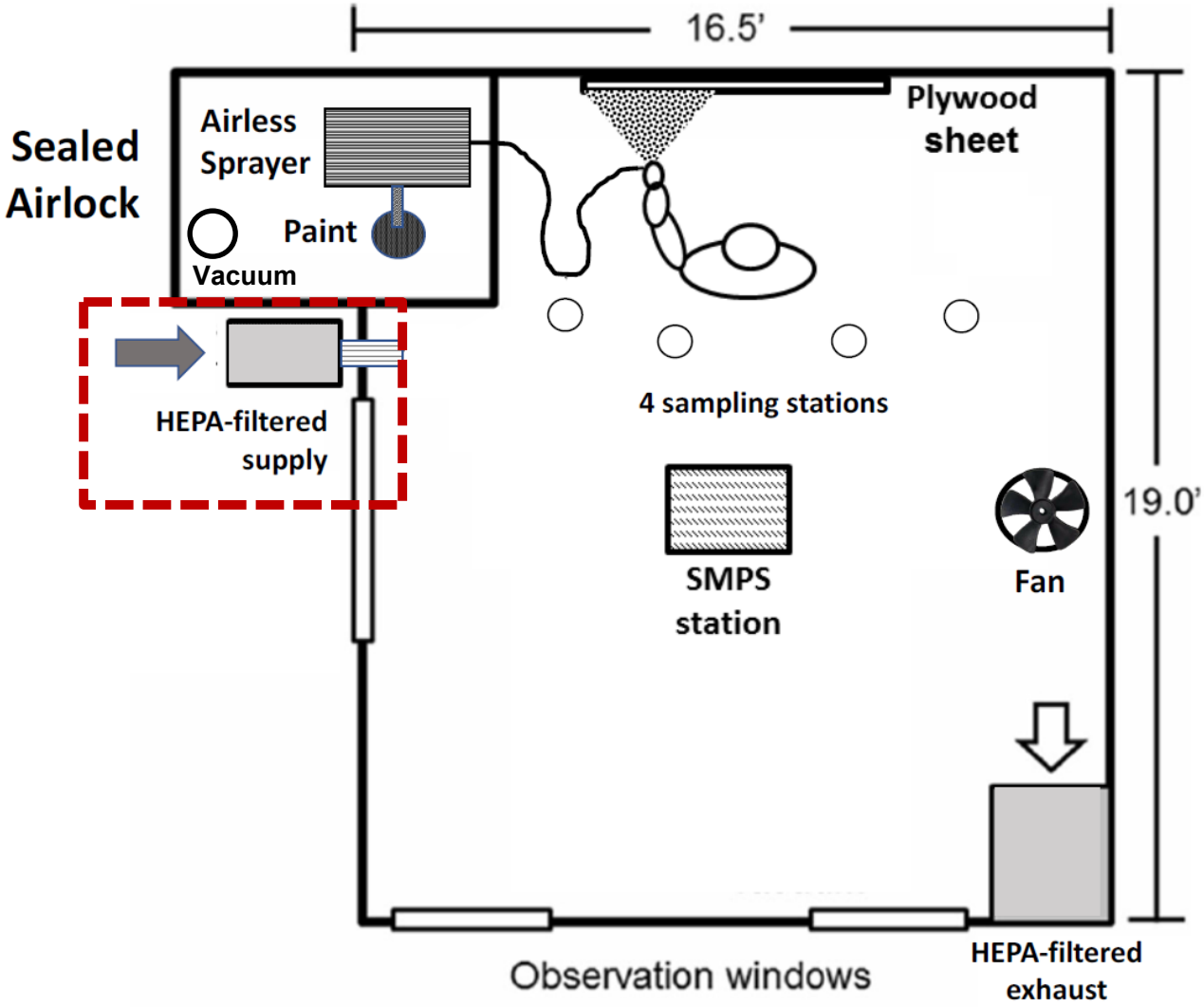


75,000 x



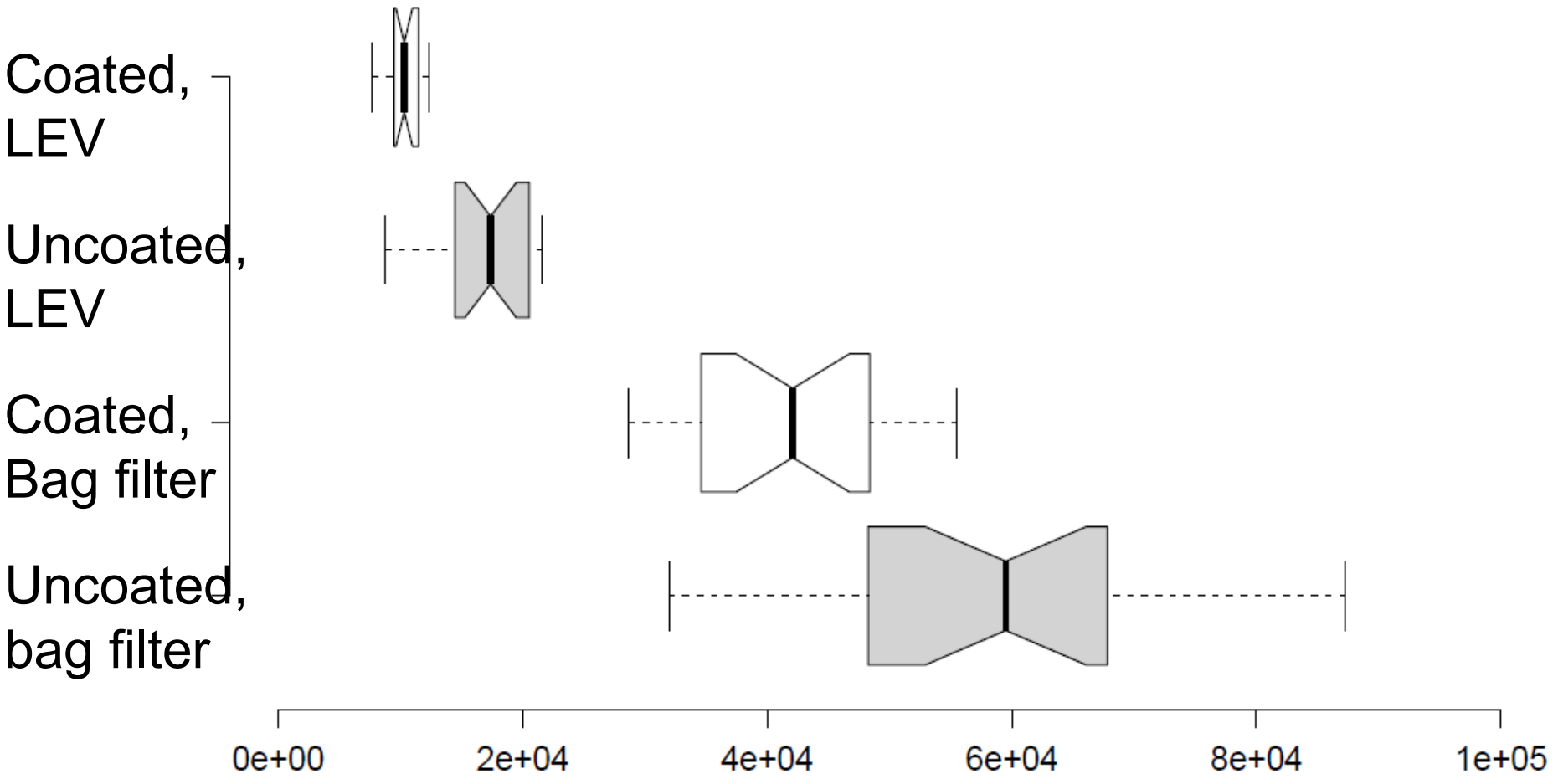
80,000 x

We used an environmental chamber with HEPA-filtered air



We sprayed and then sanded plywood sheets

We again demonstrated LEV can significantly reduce nanoparticle release



"This study may be the first to provide evidence suggesting potential for overexposure to nano-TiO2 during routine construction activity in reference to the NIOSH REL for ultrafine TiO2 (0.3 mg/m3 as a 10-hour TWA)"

West et al., draft manuscript

Personal air sampling data

Exposure Agent	N	Mean Conc. (mg/m^3)	Std. Dev.	95%CI
Total Particulate	5	35.8	8.6	25.1 - 46.5
TiO_2	5	13.6	3.2	9.6 - 17.6
Respirable Particulate	5	2.1	0.7	1.2 - 3.0
Respirable TiO_2	5	0.7	0.1	0.5 - 0.9

What are we doing to understand the hazard posed by construction nanomaterials?

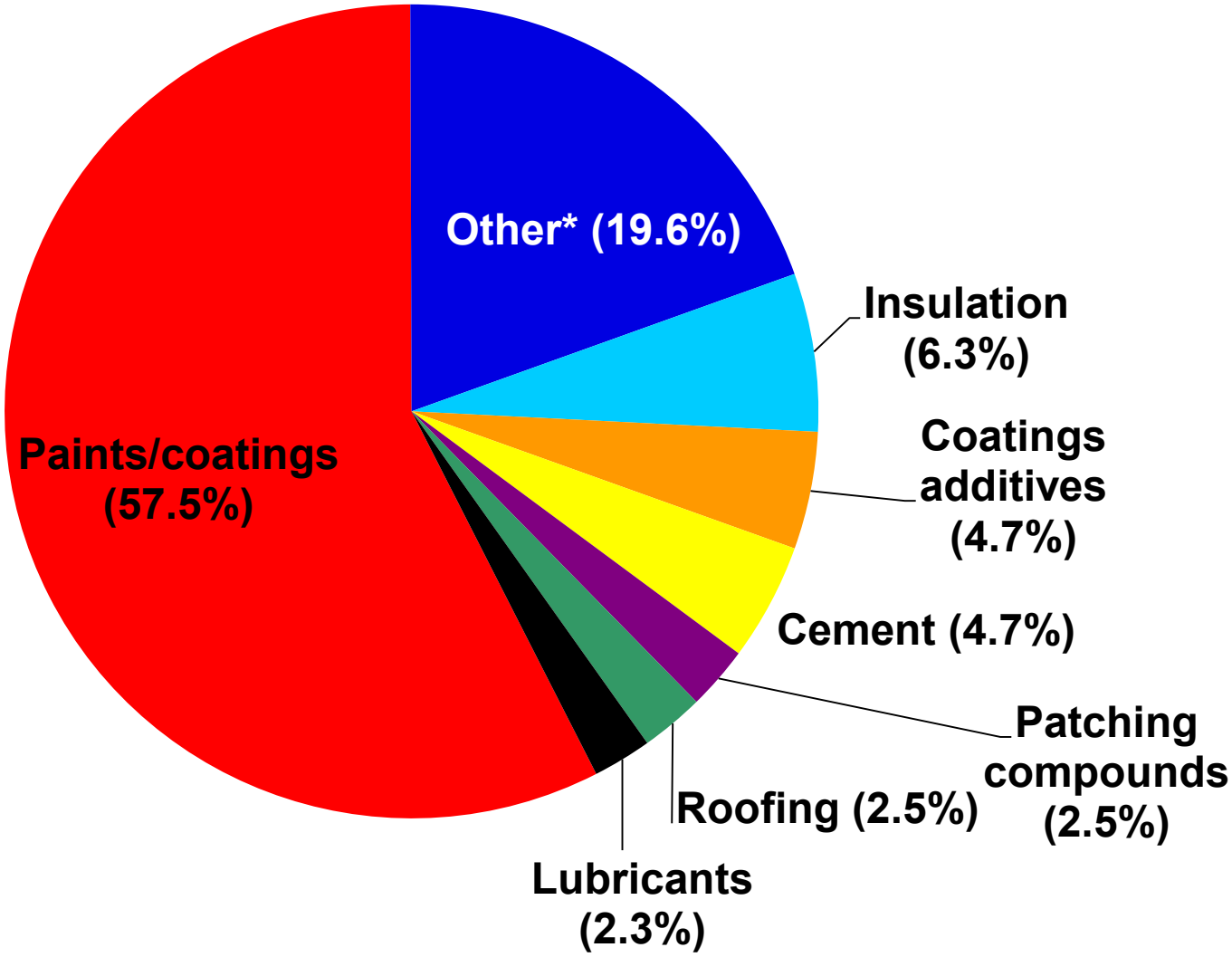
Question 3

1 2 3

Our site currently features 583 *commercial* construction products reported to be nano-enabled and 265 articles

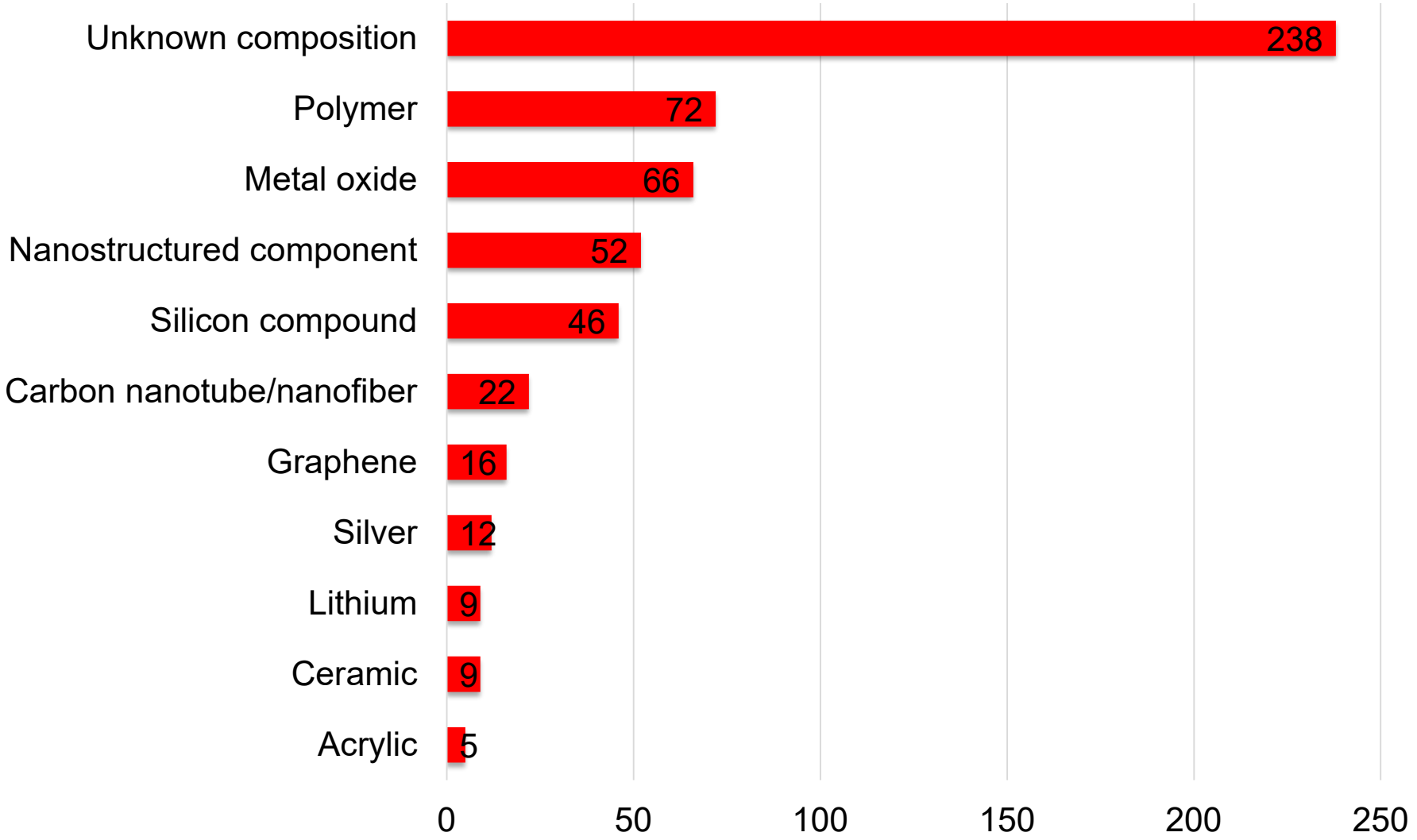
www.nano.elcosh.org

Paints and coatings still dominate



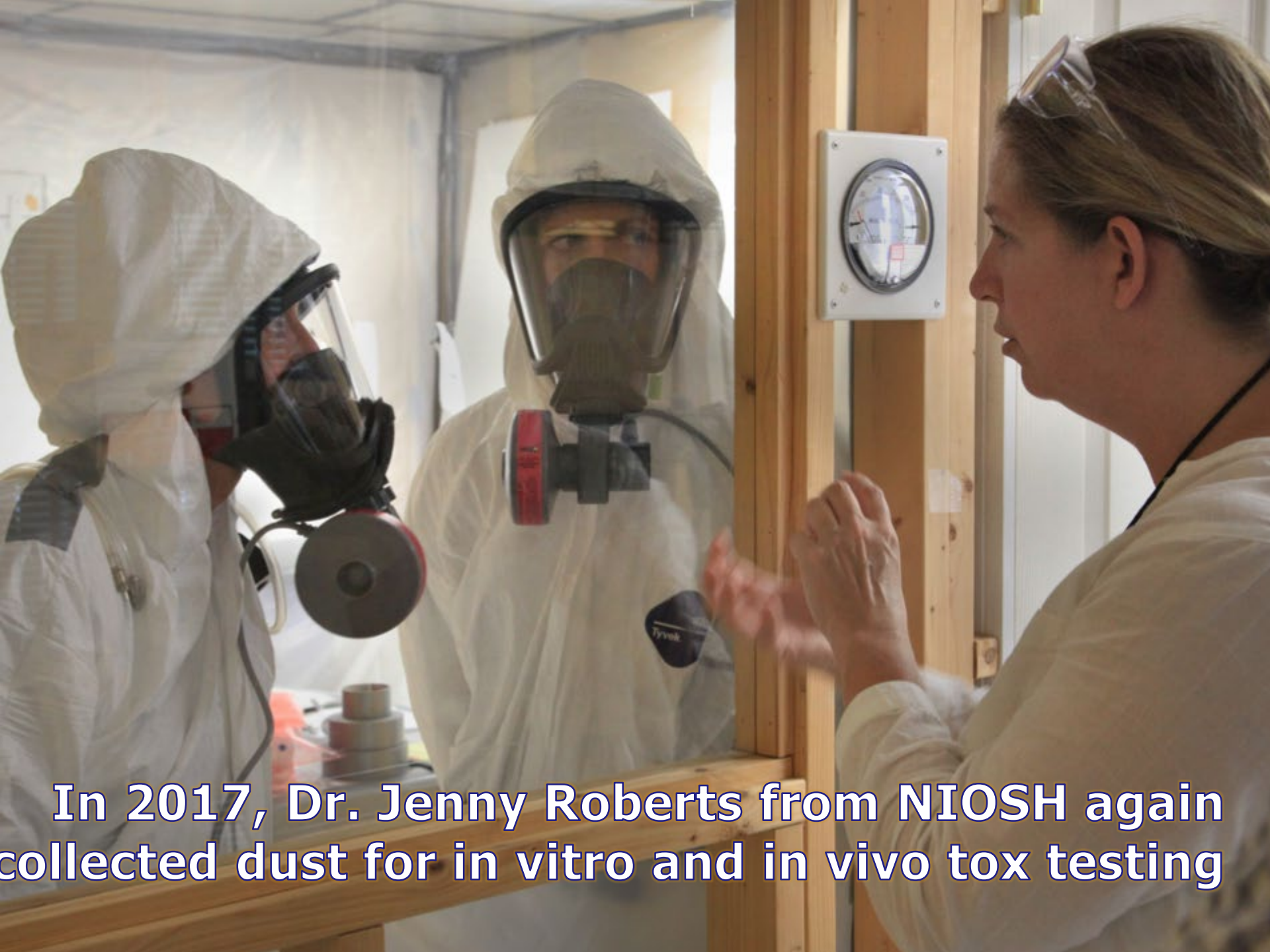
Draft Chart Book graphic (2a)

"Unknown composition"represent the largest group (number of nanomaterials)



Draft Chart Book graphic (2b)

NIOSH collected aerosol samples for toxicity testing (June 2015)


In 2017, Dr. Jenny Roberts from NIOSH again
collected dust for in vitro and in vivo tox testing

How are we doing communicating risk to construction workers?

Question 4

1 2 3 4

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.

Lee et al. (2012) found critical information missing

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

Lee et al. (2012) Nanotoxicology

ISO has published a 2012 technical report for writing nano SDSs that is quite good!

ISO/TR 13329

Nanomaterials: Preparation of Material Safety Data Sheet (MSDS)

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%)

CPWR funded a Small Study focused on nanotechnology awareness

Laura Boatman and Debra Chapman, State Building and Construction Trades Council of CA

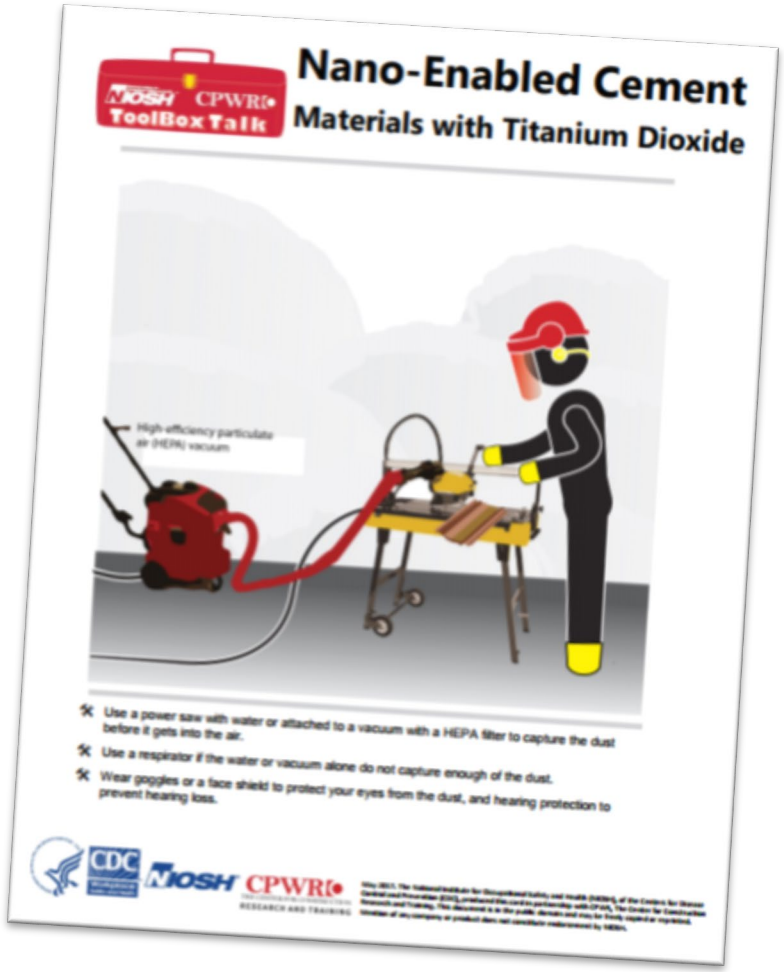
Explore awareness among CA construction unions and employers about nano

- Used questions from CPWR nano survey
- Received 253 written surveys from Survey Monkey
- Followed up with 21 key informant interviews

“Comprehensive nanotechnology training is virtually non-existent.”

Boatman and Chapman, 2018

We are creating nano toolbox talks for the trades



The AIHA Nanotechnology Working Group is a valuable resource

Thanks! Questions?

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