Nanotechnology Update
Potomac Chapter AIHA, National
Chapter AHMP and John Hopkins
School of Public Health

2-23-15

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Director of Safety Research, CPWR
blippy@cpwr.com

Shameless Pitch for CPWR!

• NIOSH-funded National Center for Construction Safety and Health for 20 years
• Construction Solutions
Who has used eLCOSH?

We have launched a web-based construction nanomaterial inventory with 400+ products

http://nano.elcosh.org
At the end of this session, I’d like you to be able to:

1. Describe recent regulatory developments
2. Explain what we know about the health problems posed by nanoparticles
3. Discuss the availability and limitations of nanoproduct inventories
4. List several findings from recent studies of releases from products
5. Describe findings from CPWR’s exposure tests for construction workers
What is the definition of an nanotechnology?

“The understanding and control of matter at dimensions between *approximately* 1 and 100 nanometers, where unique phenomena enable novel applications.” NNI

FDA has announced it may broaden its definition

Engineered to exhibit properties or phenomena, including physical or chemical properties or biological effects, that are attributable to its dimension(s), even if these dimensions fall outside the nanoscale range, up to one micrometer (1,000 nm).

*Considering Whether an FDA-Regulated Product Involves the Application of Nanotechnology: Guidance for Industry, June 2014*
“FDA has not established regulatory definitions of nanotechnology, nanomaterial, nanoscale, or other related terms” June 2014

Considering Whether an FDA-Regulated Product Involves the Application of Nanotechnology: Guidance for Industry, June 2014

Nonbinding Recommendations

36% of food-grade TiO₂ were below 100 nm; candies and chewing gums have highest content (Weir et al. 2012)

Case study: Dannon Plain Greek Yogurt

Rebuttals by Dannon

Revisions

Weir et al.

Wilson Center PEN

Mother Jones Magazine

Is Big Dairy Putting Microscopic Pieces of Metal in Your Food?

EPA continues to regulate nanomaterials under TSCA’s SNURs for Premanufacture Notices (PMN)

- July 8, 2014 promulgate SNUR for 2 CNTs
- PMN# P-10-5: conductive coating (CAS confidential)
- PMN# P-11-339: additive to resins, thermoplastics and elastomers for reinforcement and electrical performance
- Requires: PPE, defined volume of production, and no surface water releases
EPA requires full-face N-100 cartridge respirators for CNT manufacturers under a consent order, unless they prove no exposure.

Any issues with this?

Image courtesy North Company

CPSC’s FY16 budget includes $5M for a center for nanotechnology

Center for Consumer Product Applications and Safety Implications of Nanotechnology

“To identify nanomaterials in consumer products and understand effects on human exposure.”

Image courtesy North Company
EHS research made up 7% of the 2015 federal nanotechnology budget and construction is an afterthought.

NIOSH’s portion of the total federal nano research budget for 2015 is 0.7%.
NIOSH has a strategic plan for research 2013-2016 you can review online

NIOSH has created solid guidance on controlling exposures during production and downstream handling.
There are no OSHA PELs, but there are recommended OELs

<table>
<thead>
<tr>
<th>Nanomaterial</th>
<th>OEL (mg/m³)</th>
<th>Ref</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titanium dioxide</td>
<td>0.3 ultrafine</td>
<td>NIOSH REL</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>2.4 fine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWCNTs</td>
<td>0.05</td>
<td>Bayer Co.</td>
<td>2010</td>
</tr>
<tr>
<td>CNTs and nanofibers</td>
<td>0.001</td>
<td>NIOSH REL</td>
<td>2013</td>
</tr>
</tbody>
</table>

1-30-15, ACGIH announced “nanoscale primary particle notation” is under study for a TLV

Comments are solicited
The Europeans have a number of initiatives underway

2013 guidance for employers and safety practitioners and a separate one for workers

“If you are uncertain if nanomaterials are used in your workplace ask your safety rep or employer.”

The EU guidance uses the precautionary principle and control banding
Employers and practitioners should determine risk level

### Table 4.7: Control Banding: Risk Level = Concern Category x Level of Exposure

<table>
<thead>
<tr>
<th>Concern Category</th>
<th>Low</th>
<th>Medium-low</th>
<th>Medium-high</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Medium-low</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Medium-high</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>High</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

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
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)*

The ISO recommends an precautionary approach

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

- with clear and concise writing
- for each form of the same chemical that poses different hazards
- using GHS hazard statements

Nano SDSs should consider fire risks

- Nano powders may show “unusually high reactivity for fire, explosion and catalytic reactions”
- Nanomaterials reactivity may not be anticipated based on chemical composition alone
- Decreasing particle size reduces minimum ignition energy
Minimum ignition energy decreases exponentially with particle diameter

![Graph showing the relationship between minimum ignition energy and median diameter for Polyethylene and Aluminum.](image)

Netherlands Organization for Applied Scientific Research

Explain what we know about the health problems posed by nanoparticles

**Objective 2**
Humans have dealt with natural nanoparticles for a long time

![Mount Rinjani in Indonesia, Image courtesy Wikimedia](image)

The first case of human health effects was documented in 2014

- 26 year-old female chemist
- Weighed nickel nanoparticles on a lab bench with no protective measures
- Developed nickel sensitization
- Had difficult time returning to work even in other parts of the building

NIOSH has commented on this case:

http://blogs.cdc.gov/niosh-science-blog/2014/05/28/nickel-nano/

Journeay & Goldman, 2014 AJIM
Carbon nanotubes are still being compared to asbestos

![Image of CNTs and Chrysotile fibers]

Photo courtesy Andreas Saldivar, AMA Analytical

Mesotheliomas have been produced in mice with MWCNTs that are fibers with long aspect ratios (Takagi 08, Poland 08)

![Image of MWCNT penetrating pleura]

Multi-walled carbon nanotube penetrating the pleura of the lung. Courtesy of Robert Mercer, and Diane Schwegler-Berry, NIOSH
Broad range of nanomaterial types and varieties of surface coatings means *in vitro* toxicology will dominate

What is the main route of entry for nanoparticles?

- Up to 50% of inhaled nanoparticles may deposit in gas exchange region (Schulte)
- Inhaled NPs may enter the blood stream and translocate to other organs

Contact Christie Sayes: csayes@rti.org
Workers may be at risk of lung lesions exposed to SWCNTs 20 days at 5 mg/m$^3$


Nanoparticles deposit in the alveolar region
Translocation out of the lung

Skin cannot be ruled out as a potential route of exposure, but results are mixed

- Several studies show little penetration of nanoscale oxides beyond surface skin layers
- Metal nanoparticles have been shown to penetrate flexed, damaged or diseased skin
- Quantum dots were found to penetrate intact pig skin within 8-24 hours at occupationally relevant doses
Ingestion is a viable route of entry, particles can translocate throughout the body

- Ingested nanoparticles translocate to other organ systems
- SWCNT delivered into gut for treating Alzheimer's disease were found in liver, brain and heart
- Ingestion of colloidal silver can result in permanent discoloration of skin, nails and eyes

Ingested nanoparticles have been shown to...

- Slightly damage liver (silver)
- Trigger immune response in intestinal cells (TiO$_2$ and SiO$_2$)
- Be cytotoxic to human intestinal cells (TiO$_2$, SiO$_2$ and ZnO)
- Damage DNA of human intestinal cells (ZnO)
- Be genotoxic to liver and lungs after oral administration (C$_{60}$ and SWNT)
We know how to reduce harmful effects through surface modifications
Courtesy Sally Tinkle, NIEHS

Fullerene

Derivatized Fullerene

Sayes et al., NanoLet, 2004

Discuss the availability and limitations of nanoproduct inventories

Objective 3
No person or entity knows how many nano-enabled products are in commerce?

The Wilson Center’s Project for Emerging Nanotechnology has over 1,600 products on their site.
CPWR has the most complete inventory of construction nanomaterials in the world

What is our criteria?
• Manufacturer’s reference to nano
• Use of term “nano” in product or company names
• Product description suggests presence of nano
• Product cited elsewhere as using nano

CPWR has identified 412 products that are probably nano-enabled
Commercial activity of nano-enabled construction product manufacturers and distributors (N=102)

Do not appear active in USA 25%
USA address or exports 75%

Nanocoatings revenues are estimated to be $8.17 billion by 2020

Graphic courtesy Grand View Research, Inc.
NewLook International, Inc. Graf-X WB™

Material Safety Data Sheet  SDS

Section 1  PRODUCT & COMPANY IDENTIFICATION

Product Name:  Graf-X WB™ Permanent Anti-Graffiti Coating
Manufacturer's Name:  NewLook International, Inc.
Manufacturer's Address:  1525 South Gladstone Street, Suite B, Salt Lake City, UT 84104
Information Phone:  NewLook International, Inc. 877.783.9566 or 801.880.9495
Emergency Contact:  For Emergency information, contact ChemFace, Inc. at 800.236.2604. Outside the USA at 813.248.0565

Section 2  COMPOSITION & INFORMATION ON INGREDIENTS

<table>
<thead>
<tr>
<th>CHEMICAL NAME</th>
<th>CAS Number</th>
<th>Weight % in less than</th>
<th>TLV-TWA</th>
<th>TLV-STEL</th>
<th>PEL-TWA</th>
<th>Skin Designation</th>
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</thead>
<tbody>
<tr>
<td>Diethylene Glycol Monomethyl Ether</td>
<td>111-80-0</td>
<td>10% to 20%</td>
<td>No Info</td>
<td>No Info</td>
<td>No Info</td>
<td>Yes</td>
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<tr>
<td>Zinc Ammonium Carbonate Compound</td>
<td>38714-47-6</td>
<td>25% to 39%</td>
<td>No Info</td>
<td>No Info</td>
<td>No Info</td>
<td>No</td>
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<tr>
<td>Titanium Nano Drivers</td>
<td>13463-87-7</td>
<td>5% to 10%</td>
<td>No Info</td>
<td>No Info</td>
<td>No Info</td>
<td>No</td>
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<tr>
<td>Tributyl Phosphate</td>
<td>75-51-3</td>
<td>5% to 10%</td>
<td>No Info</td>
<td>No Info</td>
<td>No Info</td>
<td>No</td>
</tr>
<tr>
<td>Polymeric Hybrid Nano Particles</td>
<td>25666-24-7</td>
<td>1.0% to 3%</td>
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<td>No Info</td>
<td>No Info</td>
<td>No</td>
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<tr>
<td>Plixi Acrylic Nano Fusion</td>
<td>6063-87-0</td>
<td>17% to 29%</td>
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<td>No Info</td>
<td>No Info</td>
<td>No</td>
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<tr>
<td>Polycarbonate Nano Drivers</td>
<td>25637-46-0</td>
<td>15% to 29%</td>
<td>No Info</td>
<td>No Info</td>
<td>No Info</td>
<td>No</td>
</tr>
<tr>
<td>Hydrogen Hydroxide</td>
<td>7722-18-8</td>
<td>0% to 0.5%</td>
<td>No Info</td>
<td>No Info</td>
<td>No Info</td>
<td>No</td>
</tr>
</tbody>
</table>
Not all properties are more robust in nano-sized particles

200 nm alumina particles in organic matrix provide the maximum scattering of light

250 nm alumina particles provide greatest gloss protection in sealants

May 2011 Coatings Tech Magazine
The time until disposal is short

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable (Use for Less Than 1 Year)</td>
<td>43.23%</td>
</tr>
<tr>
<td>Short-Term Durable (Use for 1-5 Years)</td>
<td>26.29%</td>
</tr>
<tr>
<td>Long-Term Durable (Use for Over 5 Years)</td>
<td>23.31%</td>
</tr>
<tr>
<td>Consumable (Does Not Enter Waste Stream Directly)</td>
<td>7.17%</td>
</tr>
</tbody>
</table>

Graphic from David Rejeski, Wilson Center

I used to joke that nano condoms was one product we wouldn’t see

Research underway by Boston University School of Medicine
List several findings from recent studies of releases from products

Most of these are from presentations at NanoSafe2014 at Minatec in Grenoble, France
How comes Balimer don’t have no chateaux, hon?

Photocatalytic cement containing TiO$_2$ is being used in Europe

Gian Luca Guerrini, “Photocatalytic performances in a city tunnel in Rome. NOx monitoring results” Construction and Building Materials 27 (2012) 165–175
There was a reduction in nitric oxide of 20 - 60% in the tunnel before the renovation.

After the renovation, the reduction in nitric oxide was observed.

Vaquera et al. conducted worker exposure monitoring for TiO2 during full lifecycle.

Graphic from Vaquera et al. Nanosafe 2014 presentation.
Sampled during manufacturing of 1 ton of each of 3 types of mortar

Photos from Vaquera et al. Nanosafe 2014 presentation

Sampled during application, drilling and demo

Photos from Vaquera et al. Nanosafe 2014 presentation
Vaquera and colleagues concluded:

• TiO$_2$ exposures were well below the OELs for all scenarios (0.1 mg/m$^3$ Scaffold, 0.3 mg/m$^3$ NIOSH)
• Highest mass concentrations
  • Cleaning during manufacturing
  • Sol-gel spraying of depollutant on wall

Froggett presented a review of 54 studies on release of nanomaterials from solid nanocomposites

Froggett S, Clancy S, Boverhof D and Canady R (2014) Particle and Fiber Toxicology
Graphic from Froggett presentation NanoSafe 2014
Froggett et al. found:

1. Release of fine and ultrafine matrix debris from both composites and nanocomposites is common under all release scenarios.
2. Some of the debris contained the added nanomaterials either partially or fully embedded.
3. Release of the added nanomaterials fully dissociated from the matrix has been detected only occasionally.
Describe findings from CPWR’s exposure tests for construction workers

Objective 5

CPWR and EPI conducted a range of sampling during the cutting, drilling and nailing of photocatalytic tiles
We collected respirable dust, TiO$_2$ and TEM as well as CPC and OPC particle counts.

We conducted sampling during tile cutting with LEV on and off.

RIDGID 15-Amp 7 in. Angle Grinder

Ermator S26 HEPA Dust Extractor

Cut Buddy
Tester always worked in a PAPR and Tyvec with gloves and hearing protection, if needed

We used standard NIOSH methods

<table>
<thead>
<tr>
<th>Agent</th>
<th>Method</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Dust</td>
<td>0500</td>
<td>37-mm cassette with 5-micron pre-weighed, PVC filters</td>
</tr>
<tr>
<td>Titanium dioxide</td>
<td>7300</td>
<td>37-mm cassette with 5-micron pre-weighed, PVC filters</td>
</tr>
<tr>
<td>Titanium dioxide</td>
<td>7402</td>
<td>25mm open-face cassettes with 0.45-micron MCE filters</td>
</tr>
<tr>
<td></td>
<td>modified TEM</td>
<td></td>
</tr>
</tbody>
</table>
Most results were encouraging

- All measurements were below the new NIOSH REL for ultrafine TiO$_2$ of 0.3 mg/m$^3$
- Ventilation on the tool reduced respirable dust by 50% (NIOSH reported 88%)

There were unagglomerated TiO$_2$ particles, however

41% of structures counted via TEM were free and not agglomerated
### Distribution of free TiO$_2$ particles by size by TEM

<table>
<thead>
<tr>
<th>Width (nm)</th>
<th>Length (nm)</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>140</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>210</td>
<td>210</td>
<td>30</td>
<td>36.1</td>
</tr>
<tr>
<td>210</td>
<td>280</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>280</td>
<td>280</td>
<td>15</td>
<td>18.1</td>
</tr>
<tr>
<td>280</td>
<td>410</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>280</td>
<td>1040</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>350</td>
<td>350</td>
<td>12</td>
<td>14.5</td>
</tr>
<tr>
<td>350</td>
<td>410</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>410</td>
<td>690</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>620</td>
<td>620</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>690</td>
<td>690</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>690</td>
<td>900</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>1040</td>
<td>1040</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>1170</td>
<td>1170</td>
<td>1</td>
<td>1.2</td>
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<tr>
<td>1380</td>
<td>1380</td>
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<td>2.4</td>
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<td>1380</td>
<td>1730</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>1730</td>
<td>1730</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>2070</td>
<td>4140</td>
<td>1</td>
<td>1.2</td>
</tr>
</tbody>
</table>

65% < 300 nm

### Optical particle counts during surface grinding showed better LEV efficiency

<table>
<thead>
<tr>
<th>Size (nm)</th>
<th>Counts</th>
<th>LEV On (Ave)</th>
<th>LEV Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>72%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>86%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0 um</td>
<td>94%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0 um</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TSI 9306 Aerotrack

72% 86% 94% 95%
We next tested cutting in EPI’s chamber using a Bosch saw with 12” blade and Ermator vacuum.

Cutting across bevels was challenging for the ventilation.
Use of ventilation in chamber was quite effective (cutting longitudinally)

<table>
<thead>
<tr>
<th>Sample</th>
<th>LEV On (mg/m³)</th>
<th>LEV Off (mg/m³)</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total dust (area)</td>
<td>19.79 (n=15)</td>
<td>675 (n =12)</td>
<td>97.1%</td>
</tr>
<tr>
<td>TiO₂ (area)</td>
<td>0.11 (n=15)</td>
<td>1.97 (n=12)</td>
<td>94.2%</td>
</tr>
<tr>
<td>Resp dust (personal)</td>
<td>4.44 (n=8)</td>
<td>81.17 (n=6)</td>
<td>94.5%</td>
</tr>
<tr>
<td>TiO₂ (personal)</td>
<td>0.04 (n = 8)</td>
<td>0.34 (n=6)</td>
<td>88.4%</td>
</tr>
</tbody>
</table>

Dust levels without controls were extraordinarily high, but TiO₂ levels were acceptable
Second round of testing was of a mortar assumed to be nano-enabled, based on claims

Manufacturer claims:

- High ductility allowing flexes without failure
- 500 times the tensile strain capacity of other cement-based products
- Resistant to UV rays
- Expected life of 100 years

The mortar contains 1.5% nano calcium silicate
Calcium silicate accelerates concrete hardening

- ACGIH TLV of 10 mg/m³
- Braun et al. showed with rat exposures to nano calcium silicate:
  - minimal to slight local irritation of the larynx at concentration 3X the nuisance dust limit.
  - Mild local toxicity (granulomatous inflammation and squamous metaplasia in larynx) was only observed in animals exposed to the high concentration of 50 mg/m³

*Arch Toxicol (2012) 86:1077–1087*

We used Sakrete for comparison

Elephant Armor

Sakrete
We sampled during the dumping and mixing with water of one bag at a time for approx 13 minute

We measured total and respirable dust, calcium silicate by NIOSH 7020 and particle counts with OPC
After each batch was mixed, it was troweled onto Hardiebacker board *outside* the chamber.

The space was wet wiped and HEPA vacuumed and purged for 20 air changes.

5 days later we ground the dry surface using this equipment:

- Bosch Rotozip grinder with Dry Diamond 3.5” wheel
- Hilti HEPA Vacuum
We ground with and without ventilation on both products

Median particle counts showed significant reductions with LEV for both at larger sizes

<table>
<thead>
<tr>
<th>Mortar Type</th>
<th>Particle Size (microns)</th>
<th>LEV (p/cubic ft)</th>
<th>No LEV (p/cubic ft)</th>
<th>% Reduction</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>0.3 – 0.5</td>
<td>302,124</td>
<td>204,609</td>
<td>N/A</td>
<td>0.31</td>
</tr>
<tr>
<td>Control</td>
<td>0.3 – 0.5</td>
<td>341,496</td>
<td>177,857</td>
<td>N/A</td>
<td>0.15</td>
</tr>
<tr>
<td>Experimental</td>
<td>0.5 - 1</td>
<td>252,141</td>
<td>743,001</td>
<td>66%</td>
<td>0.41</td>
</tr>
<tr>
<td>Control</td>
<td>0.5 - 1</td>
<td>372,844</td>
<td>667,377.5</td>
<td>44%</td>
<td>0.0019</td>
</tr>
<tr>
<td>Experimental</td>
<td>1 - 3</td>
<td>198,622.5</td>
<td>2,737,892</td>
<td>93%</td>
<td>0.016</td>
</tr>
<tr>
<td>Control</td>
<td>1 - 3</td>
<td>361,348</td>
<td>2,593,298</td>
<td>86%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Experimental</td>
<td>3 – 5</td>
<td>55,390</td>
<td>1,343,551</td>
<td>96%</td>
<td>0.023</td>
</tr>
<tr>
<td>Control</td>
<td>3 – 5</td>
<td>121,963</td>
<td>1,619,919</td>
<td>92%</td>
<td>&lt; 0.001</td>
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<tr>
<td>Experimental</td>
<td>5 – 10</td>
<td>33,479.5</td>
<td>1,076,389</td>
<td>97%</td>
<td>0.047</td>
</tr>
<tr>
<td>Control</td>
<td>5 – 10</td>
<td>87,534</td>
<td>1,727,897</td>
<td>95%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Experimental</td>
<td>10+</td>
<td>4,729.5</td>
<td>176,941</td>
<td>97%</td>
<td>0.099</td>
</tr>
<tr>
<td>Control</td>
<td>10+</td>
<td>13,149</td>
<td>353,211.5</td>
<td>96%</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

* Statistically significant at alpha of 0.05
Resources that might be useful

NIEHS has the only guidance on training workers about nanotechnology risks
An 8-hour course is available for free at two locations

The GoodNanoGuide
www.goodnanoguide.org

OSHA Training Institute

AIHA Nanotechnology Working Group

Nanotechnology Working Group

Mission

Provide AIHA members and technical committee representatives with opportunities to identify, organize, and conduct information sharing, educational activities, and community outreach in the cross-cutting area of nanotechnology safety and health.

Ongoing and Upcoming Activities and Events:

- Establishing and maintaining useful content on the AIHA Nanotechnology topic page
- Education, information, authoritative guidance, and funding resources
- Links to national and international partnering organizations
- Information on AIHA member and technical committee needs assessments to help guide effective collaboration and progress

Fostering industrial hygiene input to the development of national and international standards
Thanks! Questions?
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