Nanotechnology Research at NIOSH

Delivering on the Promise through Responsible Development

Cellulose Nanomaterials: A Path Towards Commercialization

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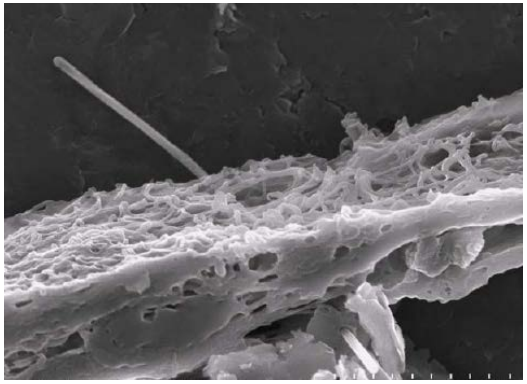
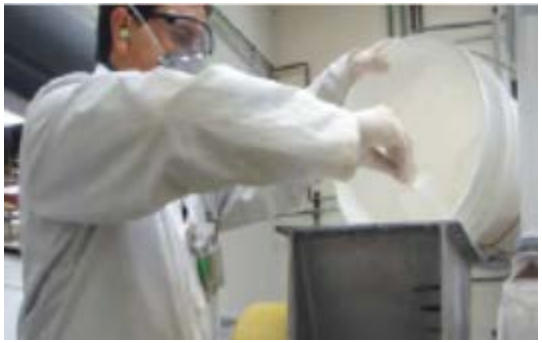
Nanotechnology Research Center
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Meeting the challenge with a diverse portfolio of lab and fields projects



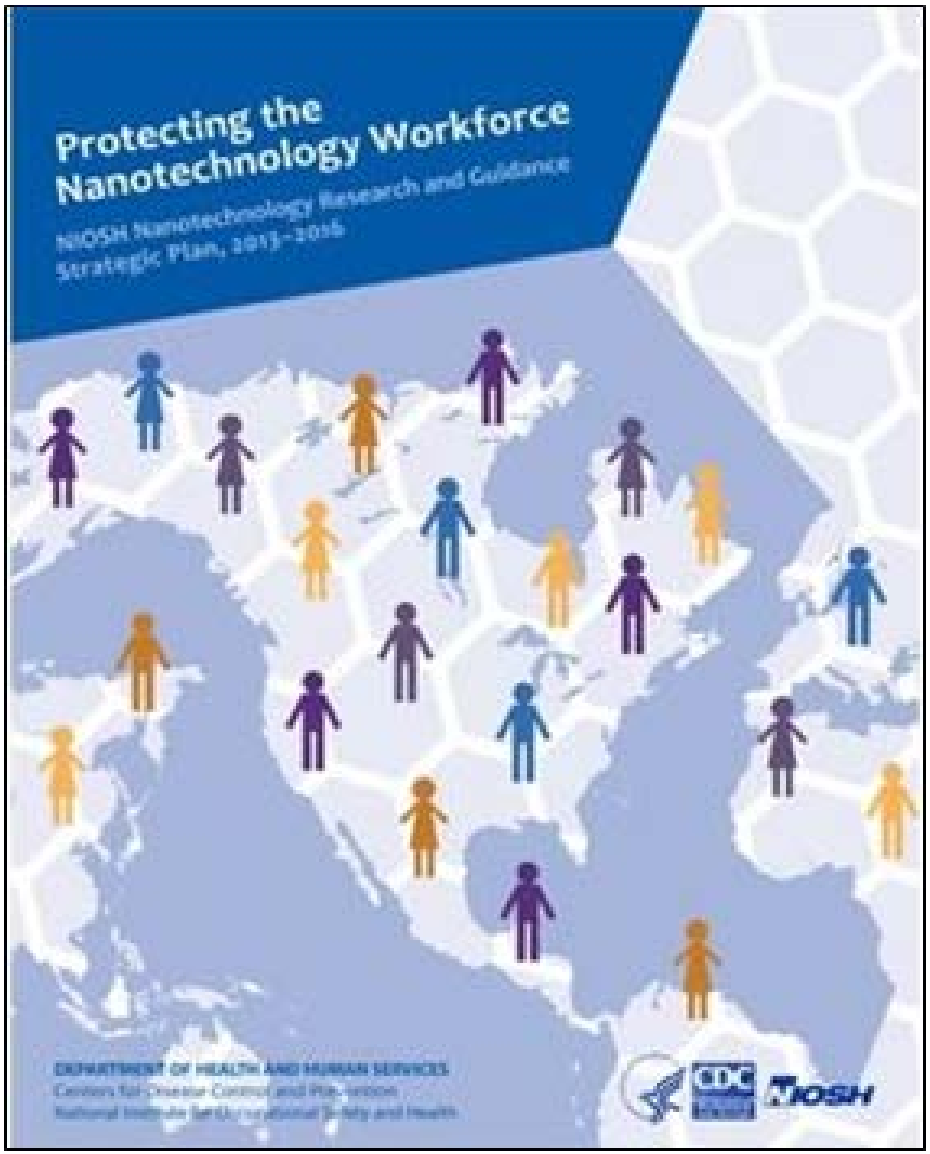


Why the Workplace?

- Workers generally the first people in society exposed to a new technology and its materials
- Nanotechnology is no exception
- More than 1,000 nano-enabled products reportedly in commerce
- Workers make and use them; from R&D labs, to concept testing, to manufacturing.
- First opportunity to develop good stewardship practices

Nanotechnology Research Center

- Chartered in 2004
- Over 50 projects; 50 scientists (25 FTEs) ; FY 12 investment of $10MM
- Cross-Institute matrix for greatest efficiency
- Published over 400 papers in scientific journals (2004 through 2011)
- Developed public-private partnerships with nanotechnology companies for greatest research impact
- Provides strong guidance to protect the nanotechnology workforce
- Leverages collaborations with other government agencies
- Risk-based approach to responsible development of the technology



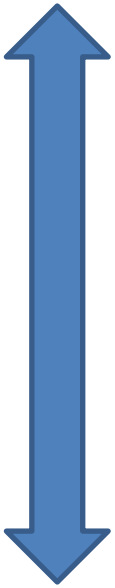
Prioritized Research

Planning the Future:
NTRC Strategic Plan
2013-2016

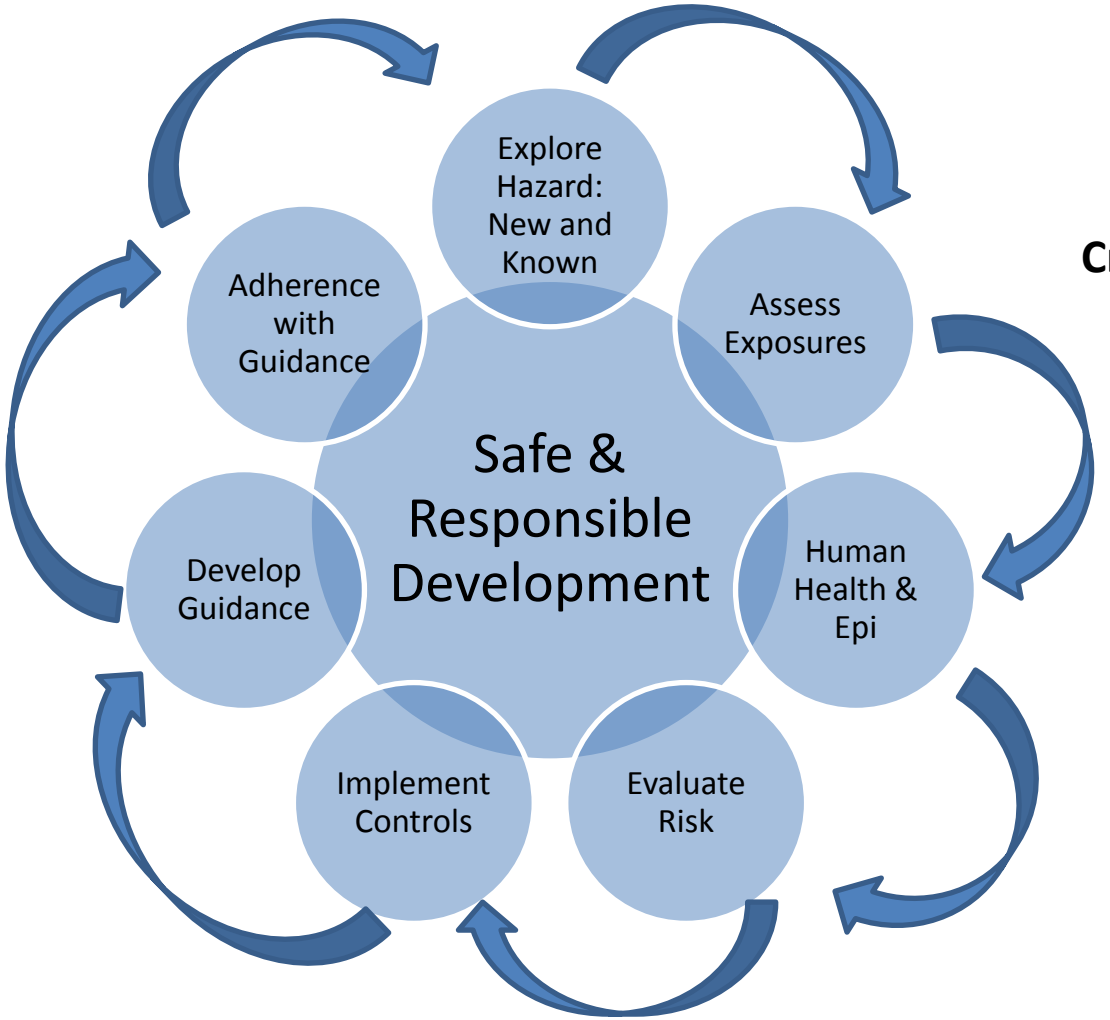
NTRC Research Program: 10 Critical Topic Areas

1. Toxicology and internal dose
2. Measurement methods
3. Exposure assessment
4. Epidemiology and surveillance
5. Risk assessment
6. Engineering controls and PPE
7. Fire and explosion safety
8. Recommendations and guidance
9. Communication and information
10. Applications

A concurrent approach to match the pace of innovation.



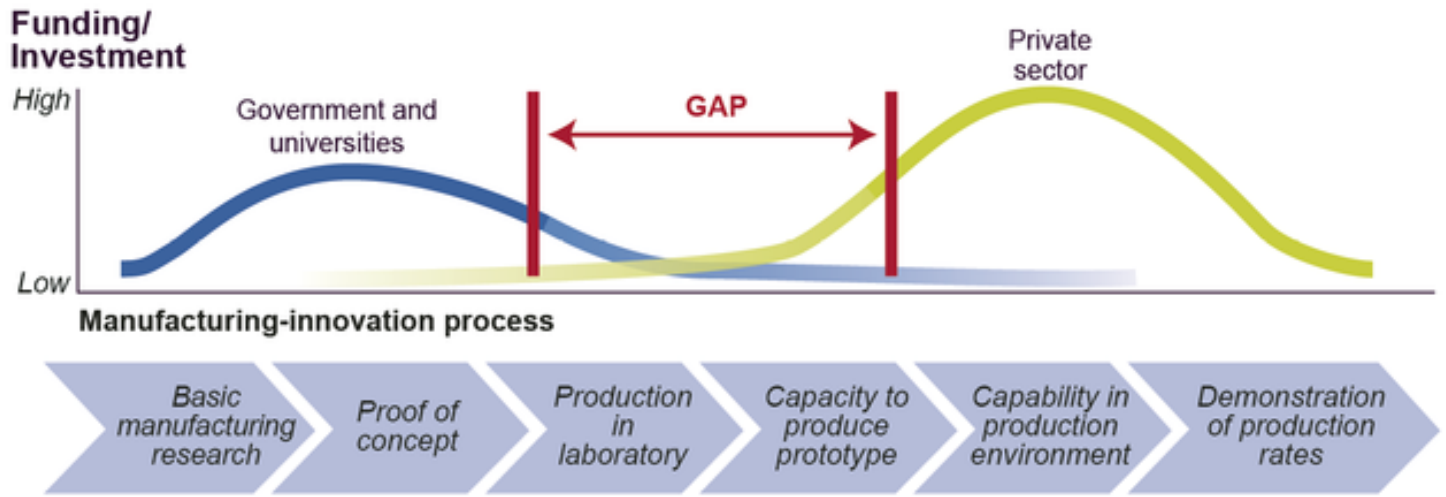
A Risk Management Approach to Protecting the Nanotechnology Workforce



Create Links

Our Role in Helping to Bridge the Gap
-AKA the Valley of Death-
Worker Protection is a Strut in the Bridge

Funding/Investment Gap in the Manufacturing-Innovation Process

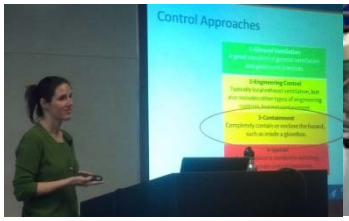


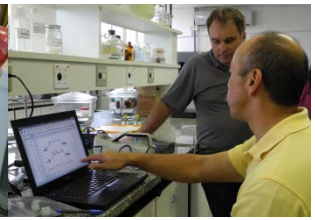
Source: GAO adapted from Executive Office of the President.

NIOSH Site Studies

Exposure characterizations for a wide variety of materials

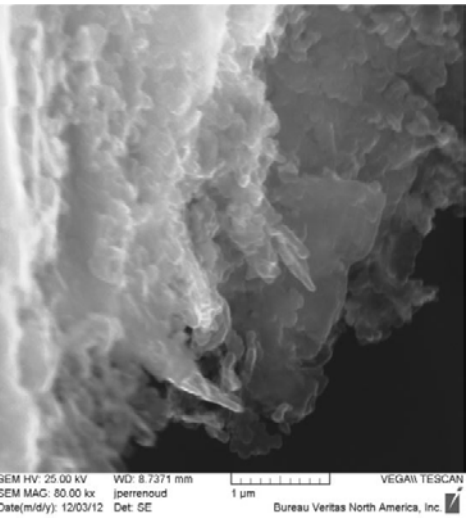
- MWCNT & SWCNT
- CNF, Fullerenes, and Graphene
- Silica and Aluminum oxide
- Quantum Dots
- Silver nanowires
- Metal oxides (Mn, Co, Ag, Fe, Al, Cu, Hf, Pd)
- Hafnium and Zirconium
- Nanocellulose crystals and fibrils
- Cellulose Acetate
- Cobalt
- Titanium Dioxide



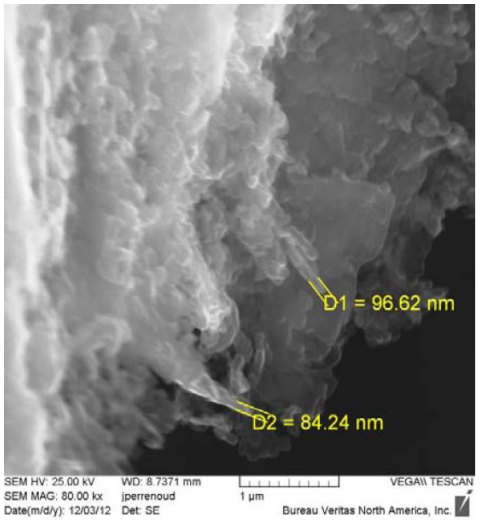


Nanocellulose – A unique challenge

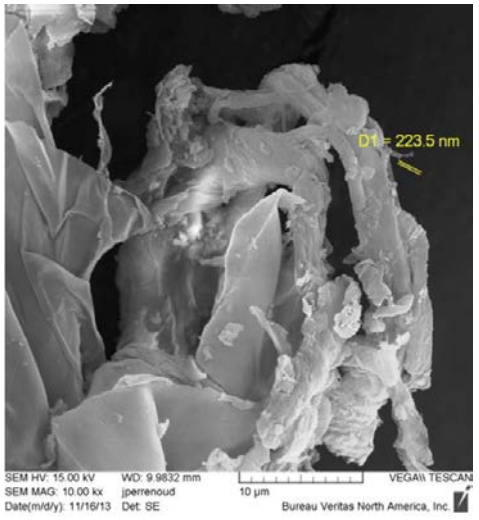
- No validated analytical method for nanocellulose currently exists
- Electron microscopy allows for detection and visualization
  - Filter preparation issues



Cellulose nanocrystals

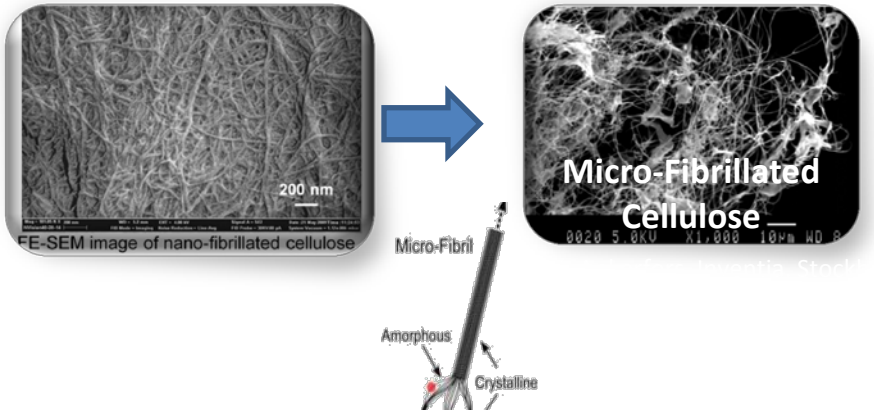


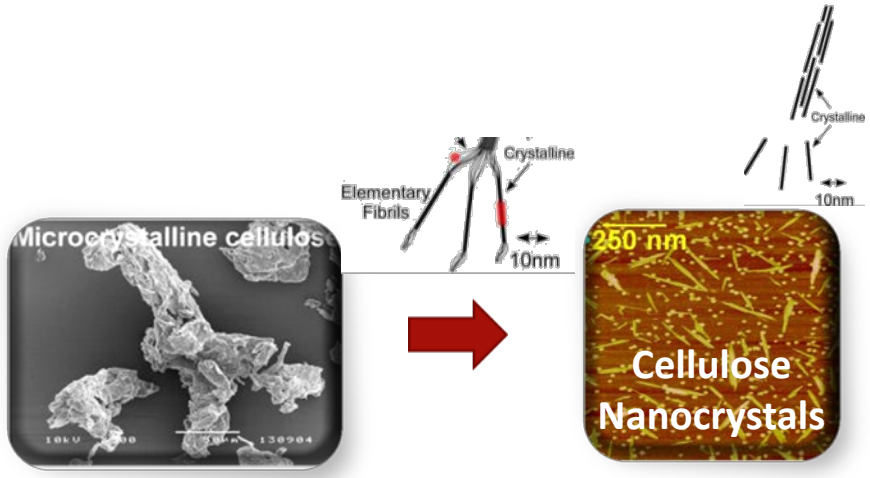
Cellulose nanofibrils



Nanocellulose production facility

- Production process is based on one that was first published in 1949[1]
- Currently, facility produces:
  - Cellulose Nanocrystals - 5 nm diameter and 200 nm long
  - Cellulose Nanofibrils - 10-30 nm diameter and >100 nm long
- Based on the chemistry of the process, the products can be tagged by exchanging sodium ions with an alternative alkali metal





[1]Ranby BG. Aqueous colloidal solutions of cellulose micelles. Acta Chem. Scan.; 1949. p. 649-50.

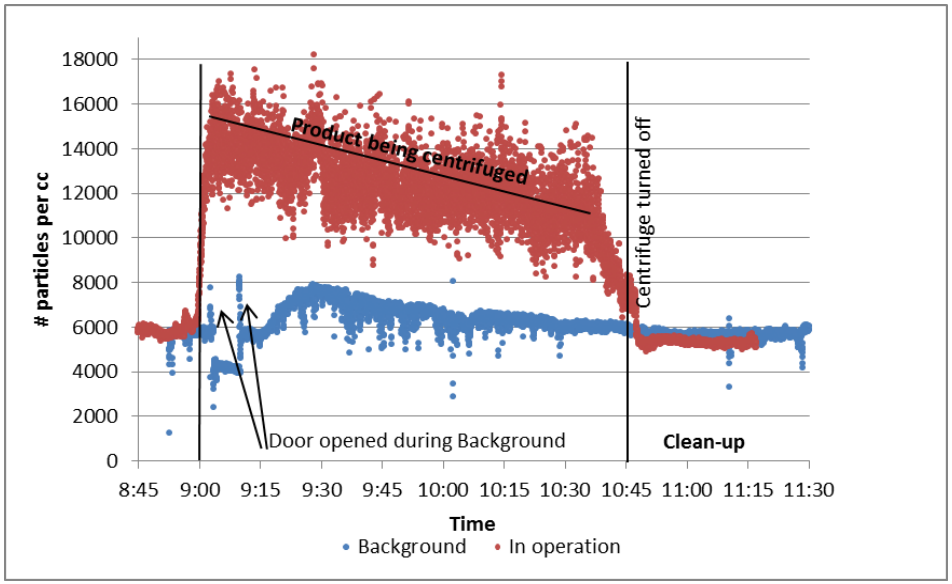
NIOSH characterizes potential exposure to nanocellulose

- Facility agreed to tag product with cesium to increase the ability for detection
- The following tasks involving the use of tagged product were evaluated by the NFST:
  - Centrifugation of CNC product slurry
  - Removal of dried CNC product from a freeze dryer – general ventilation
  - Removal of dried CNF product from a freeze dryer - HEPA LEV
  - Production, cutting, and milling of CNC polymer composite

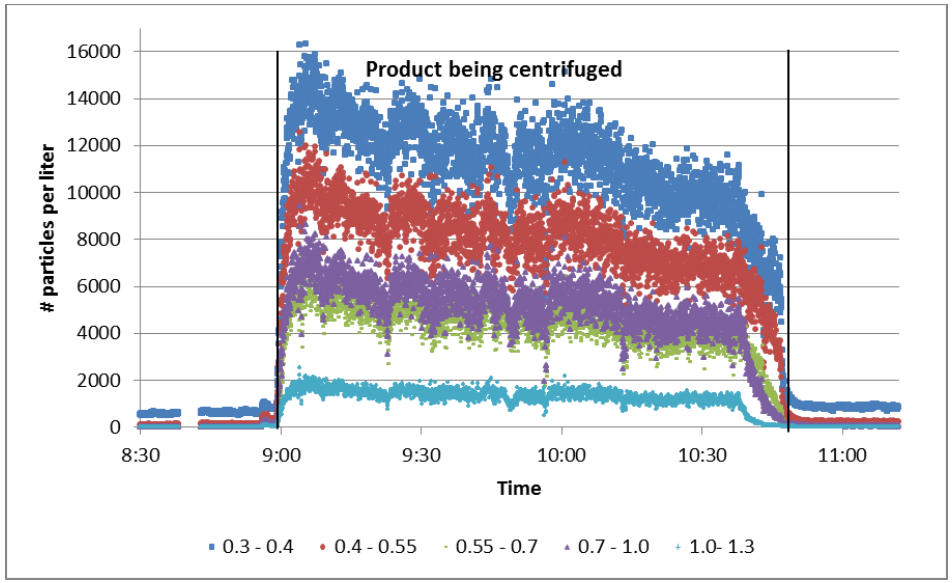



Centrifugation Exposure Characterization

CNC product



Condensation particle counter



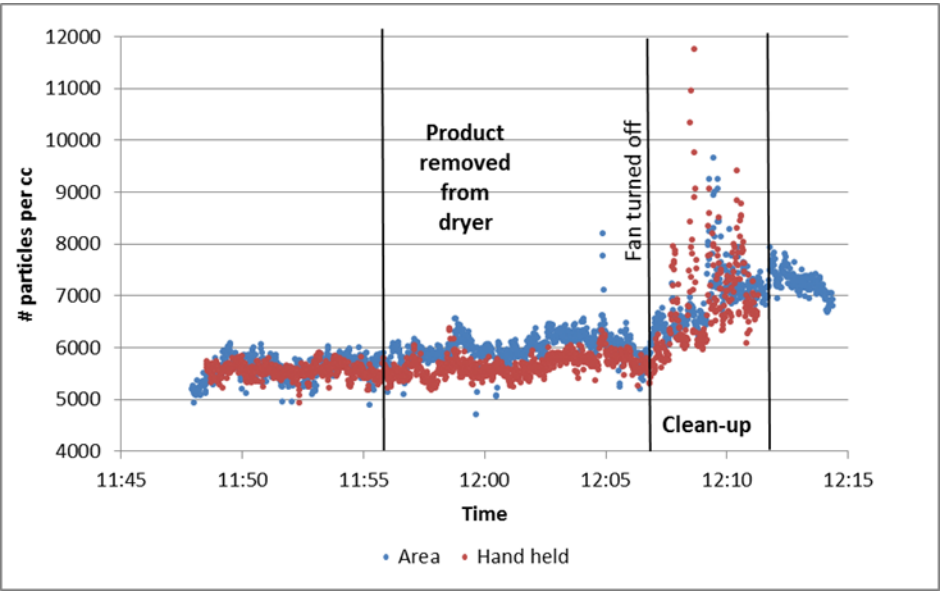
Optical particle sizer

- 3 open-face filter samples collected for cesium – all samples positive
- Highest level was inside centrifuge cabinet, second highest was just outside cabinet
- Both PBZ and Background (located away from process) showed cesium

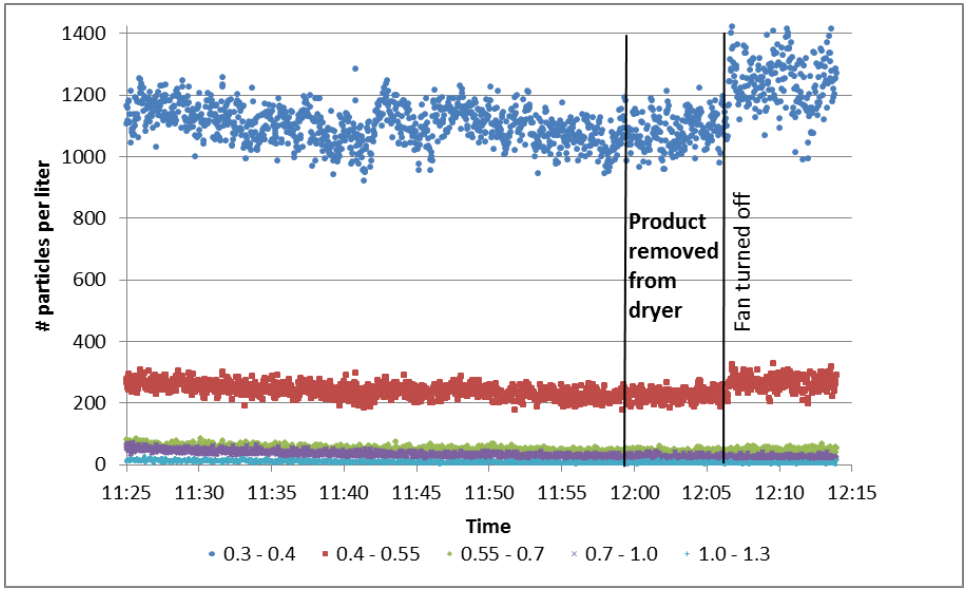
Facility no longer uses the centrifugation process

Freeze Dryer Exposure Characterization – Warehouse general ventilation

CNC product



Condensation Particle Counter

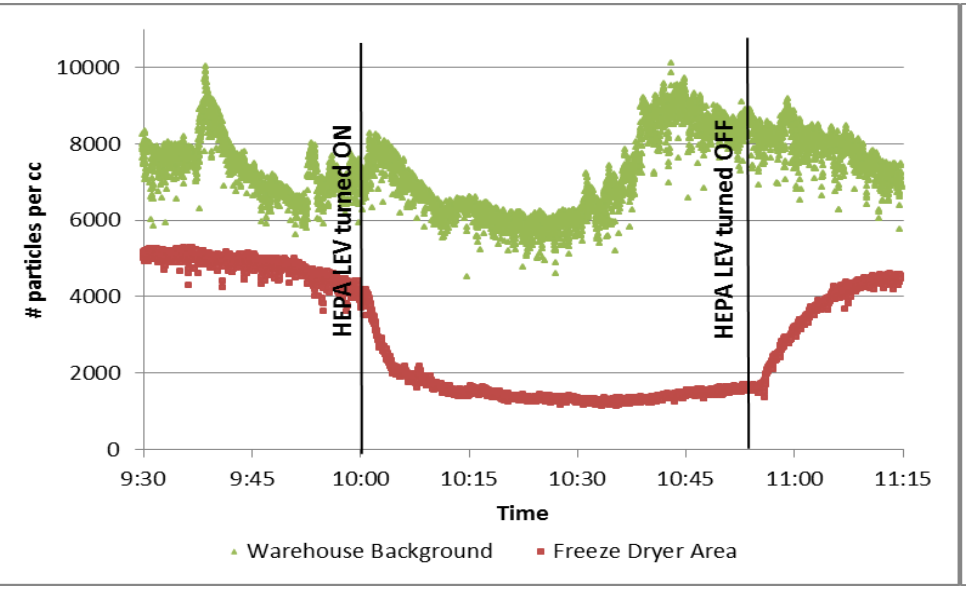


Optical Particle Sizer

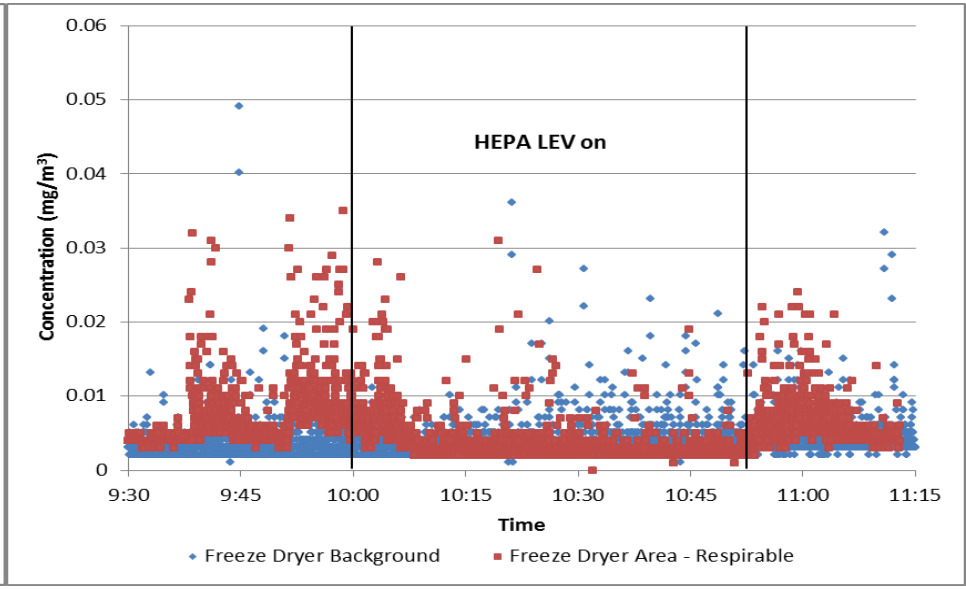
- 3 samples collected for cesium – all samples positive
- Highest level was located on the freeze dryer, second was close to where dried product was being removed from the tray
- PBZ showed cesium

Freeze Dryer Exposure Characterization – Inside room using LEV

CNF product



Condensation Particle Counter

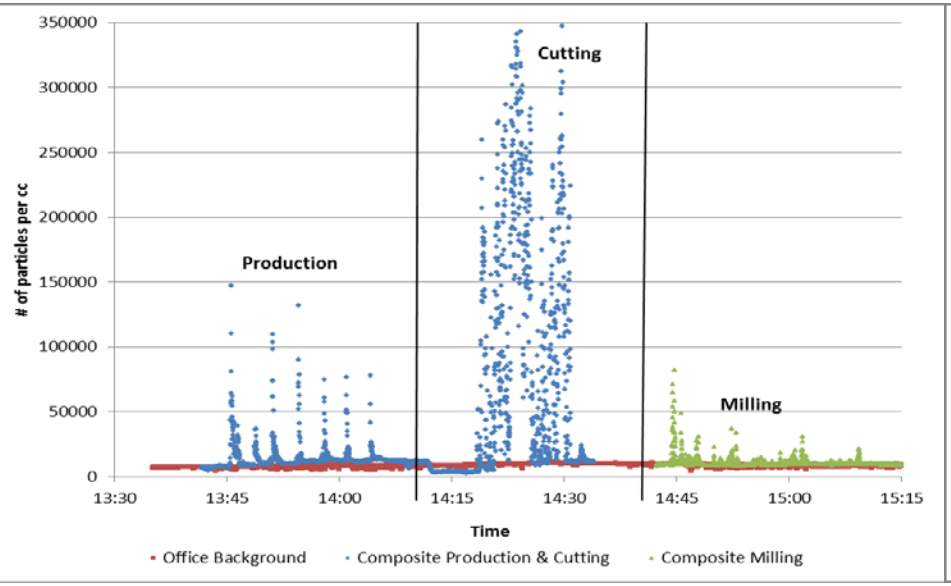


Dust Trak

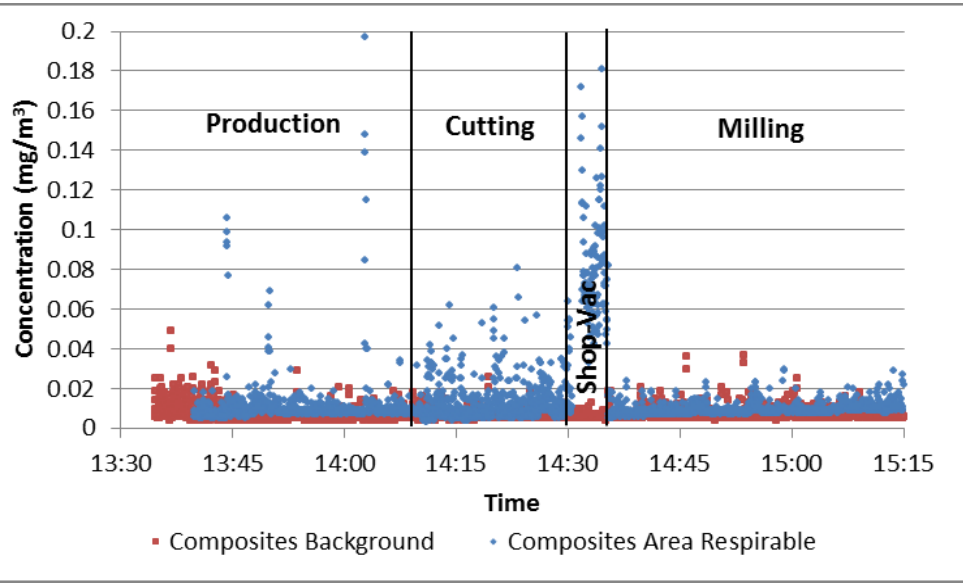
- Three area samples collected close to where dried product was being removed from the tray were analyzed for cesium –
  - One non-detectable
  - Two samples were between the LOD/LOQ (not reliably quantifiable)

Composite Production, Cutting, and Milling Exposure Characterization

CNC product



Condensation Particle Counter



Dust Trak

- 6 of 7 samples collected for cesium were positive
- Highest level was the PBZ sample, second was a source sample located close to the extruder mixer, and the third was located just between the extruder mixer and the composite press

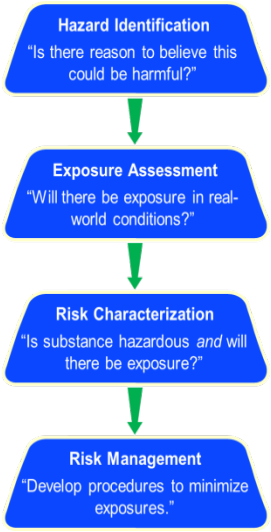
Nanotechnology Guidance Documents

Summary

Nanotechnology Research at NIOSH

Moving safely and responsibly into the future

The NIOSH Approach



Ten Critical Research Areas

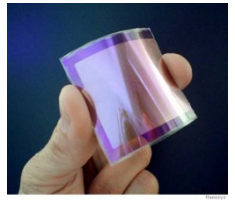
Playing a key role in the nation's investment in nanotechnology:

- **Protecting the promise** of nanotechnology, which will benefit nearly every segment of society.
- **Workers are the first** to be exposed, so safe and responsible practices begin in the workplace.

NIOSH work produces results:

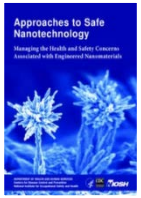
- **Safe practices** result in business success, a competitive advantage, and public trust.
- **Economic growth** will come from advancements in manufacturing.
- **Partnerships** with the private sector are key to the NIOSH success story.
- NIOSH is recognized by stakeholders as the "**most trusted and collaborative**" agency.

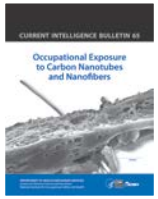
Future Products Today

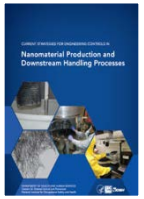


Partnerships

Guidance







NIOSH NTRC Researchers

http://www.cdc.gov/niosh/topics/nanotech/

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