Nanomaterial Exposure Measurements
-Challenges and Experiences-

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CDC Workplace Safety and Health

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Exposure (Dose) Measurement Challenges "Is Exposure Occurring?"

- What 'contaminant' is to be measured?
- Can the 'contaminant' be measured?
- Are there any guidelines?
- What dose measurement makes sense?
  - Any exposure/dose?
  - A specific portion of dose: total, respirable, etc?
- How is exposure interpreted?

Measuring Free Engineered Nanoscale Particulate Matter–“Nanoparticles”

- The ‘free particle’ is the primary focus of toxicology (hazard) studies.
- Definitions are ‘loosely’ accepted
- Comfort level: long history with ultrafine particulate measurements
- Human Exposure Challenge: the Engineered Nanoparticle as part of a complex exposure
- What is actually encountered in the human exposure?

Can Nanoparticles be measured? Sure.

But, are you measuring the ‘right’ nanoparticle, and can it be done easily?

Where do I start?

The particle haystack

The engineered nanoparticle

To get the risk management process started,
it's OK to measure the haystack.

Multiple Metrics Are Being Considered In Toxicology Studies

- Mass: Links to historical data, but lacks sensitivity and specificity in field exposure studies
- Size distribution: More information , bur not specific in field studies and not easy in nanometer ranges
- Number concentration: Fairly simple, but not specific to particles.
- Surface area: Some relevance based on toxicology, technology is available, but non-specific

What is the common metric?

Toxicology: Mass/m^3 of air

Workplace: Particle number, size, mass, etc.

The Field Experience

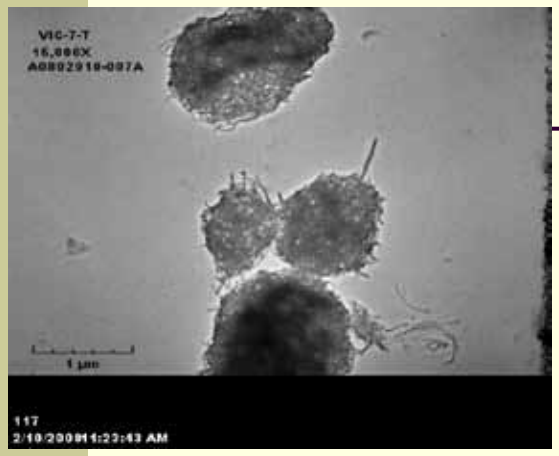
- Methods are not ‘nano material specific’
- Qualitative measurements are still the norm
- Quantitative measurements, when possible
- What is being used and seen?

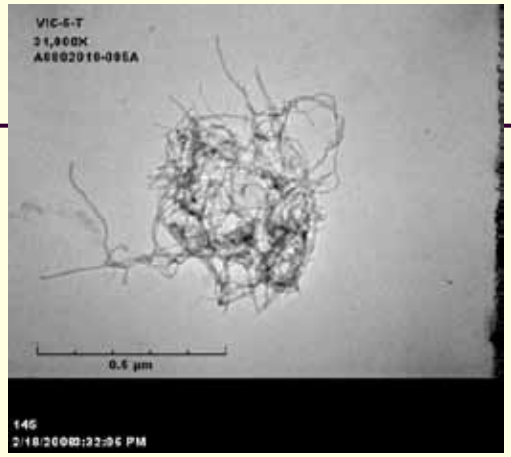
Summary of Facilities Creating/Handling Nanomaterials

Facility Type	Nanomaterial, Size, Quantity	Process Description	Controls Present	Task	CPC (1)	OPC (2)	OPC (3)	Total Carbon (µg/m^3)	Evidence TEM Filter (Yes/No)
R&D Laboratory	Carbon Nanofibers; <100 nm in diameter; 500 mg/batch	Produce composite material.	Negative pressure room, laboratory hood and HEPA-filtered vacuum	Background	19,500	N/A	N/A	15–19	No
				Weighing, mixing	4,000	N/A	N/A	64–221	Yes
				Wet sawing	5,000	N/A	N/A	1,094	Yes
Manufacturer	Carbon Nanofibers; 70–200nm diameter; 50-100 µm length; 10-20 Kg/shift	Chemical Vapor Phase reactor. Chemically treat, dry and package.	Rooftop exhaust and shop vacuum with HEPA filter.	Background	N/A	12,600	1,000	12–15	Yes
				Processing	N/A	53,600–134,800	5,400–144,900	31–248	Yes
				Drying	N/A	84,200–109,200	11,500–98,400	1,839	Yes
				Manual Scooping	N/A	73,200–127,400	52,900–139,500	1,729	Yes

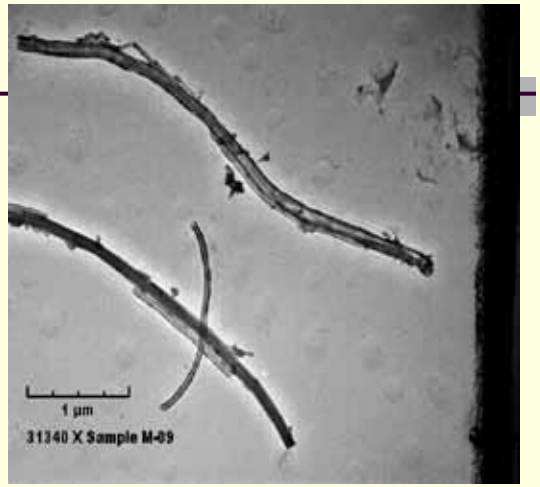
1. (P/cm3) 10-1000 nm 2. (P/L)300–500 nm 3. (P/L)500–1,000 nm

Examples of TEM Evidence

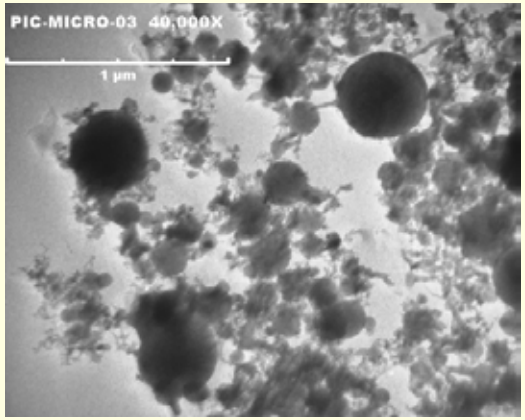




Before and after Sonication of MWCNT



Packing of CNF



PBZ – Metal oxide reactor cleaning

Not quantitative, but to verify presence and nature of the nanomaterial

What is the “Exposure Measurement Story”?

- Exposures are occurring
- Various metrics are being used
- Little specific and quantitative data
- Particle counts and mass/M3 most common uniform metrics
- Highly agglomerated, complex nature
- Toxicology studies: better characterization and more realistic doses needed – feedback from the field needed.