INTERNATIONAL SEMATECH ISMI MANUFACTURING INITIATIVE
ESH Technology Center

**Accelerating Sustainable Manufacturing**

# New Materials Research Needs

## A perspective from ISMI technology programs


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# ITRS – ESH Section

- Basic ESH Roadmap Strategies (partial list)
  - Understand (characterize) process and materials during the development phase
  - Use materials that are less hazardous, or whose byproducts are less hazardous
- Difficult Challenges – Long Term
  - Chemicals and materials management
    - Chemical assessment – need for robust and rapid assessment methodologies
    - Chemical exposure management – need for better information on how chemical/materials are used and the process by-products formed

# Nanomaterials

- Worker exposure potential – continuation of current efforts
- Effluent monitoring – development of in-situ monitoring for presence/quantity/type of nanoparticle in effluent streams
- Detection and characterization – development of monitoring methods, standardization
- Consumer exposure – study potential releasability of nanomaterials through life cycle of product

# NIOSH Intelligence Bulletin

Occupational Exposure to Nanoparticles and Nanofibers
November 2010

Research needs identified:

### 7.1 Workplace exposures, measurement, and controls

- Quantify worker airborne exposures to CNT and CNF.
- Evaluate NIOSH Method 5040 and other appropriate methods in CNT and CNF workplaces.
- Improve the sensitivity and precision of NIOSH Method 5040 and other appropriate methods for measuring airborne concentrations of CNT and CNF.
- Develop improved sampling and analytical methods for measuring airborne exposures to CNT and CNF that more closely align with the health endpoints and exposure metrics used in laboratory animal studies
- Determine the effectiveness of engineering controls to control airborne exposures to CNT and CNF below the NIOSH REL of 7 $\mu g/m^3$.

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## Research needs identified (continued):

- Confirm the effectiveness of using HEPA filters in an exhaust ventilation system for removing exposures to CNT and CNF.
- Determine the effectiveness of gloves and other PPE barrier materials in preventing dermal exposure to CNT and CNF.
- Identify, quantify, and develop CNT and CNF reference materials for toxicology studies and for measurement quality control.

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Research needs identified (continued):

### 7.2 Experimental and human studies

- Conduct chronic animal inhalation studies to assess respiratory and other organ (e.g., heart and other circulatory system) effects. Special emphasis should be placed on assessing the risk for developing lung fibrosis and cancer. Studies should evaluate different types of CNT and CNF and use various exposure metrics (e.g., tube and fiber count, surface area) for assessing toxicological responses.
- Elucidate the mechanism(s) and other causative factors (e.g., tube and fiber size, surface area, and surface reactivity) by which CNT and CNF induce adverse effects (e.g., lung fibrosis) in animals.

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## Research needs identified (continued):

- Develop early markers of exposure and pulmonary response to CNT and CNF given evidence from animal studies that CNT and CNF persist in the lungs and result in the development and progression of pulmonary fibrosis and/or cancer at relatively low mass doses.
- Quantitatively and qualitatively compare the CNT and CNF material used in the animal studies with the CNT and CNF materials found in workplace air.
- Determine the potential for CNT and CNF to penetrate the skin and cause toxicity.
- Evaluate the predictive value of using *in vitro* screening tests for assessing the hazard (e.g., fibrogenic potential) of various types of CNT and CNF.

# Research Materials ESH

- Materials Evaluation – prioritization, risk assessments and properties testing
- Predictive Toxicity – improvement of current modeling methodologies
  - Models are getting better, but significant improvement still needed
  - Evaluation of metal and metal-containing compounds limitations
  - Limited ability to characterize nanomaterials
  - Expansion of databases is needed
  - Combine system capabilities to generate better results

# Predictive Toxicity Systems

- Testing of current systems – some suggestions
  - quaternary ammonium compounds
  - perfluorinated organics of various chain lengths and functional groups (sulfonic acids, carboxylates, etc)
  - siloxanes
  - solvents used in resist systems and stripper chemistries
- What to look for, what to ask
  - How well do the estimates produced by different algorithmic approaches agree with each other?
  - How well do the predictions match those measured data that are available?