

Recommendations for Nanotechnology ESH Research

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Background



- ◆ The chemical and semiconductor industries formed Consultative Boards for Advancing Nanotechnology (CBAN) with the NNI.
- ◆ Both groups formed sub-teams to address environmental, health and safety (EHS) topics.
- ◆ Most EHS topics are not industry sector-specific, but apply broadly.
- ◆ EHS sub-teams from the chemical and semiconductor industry identified the opportunity to work jointly on EHS areas of interest.

Result: NNI-ChI/SRC ESH WG

Participants



Industry

- ◆ American Chemical Council
- ◆ Air Products
- ◆ AMD
- ◆ Degussa
- ◆ DuPont
- ◆ Intel
- ◆ IBM
- ◆ Rohm Haas
- ◆ Semiconductor Industry Association
- ◆ Semiconductor Research Association
- ◆ Dow
- ◆ Praxair

Other Stakeholders:

- ◆ NIOSH
- ◆ NIST
- ◆ NNCO
- ◆ NSF
- ◆ Oak Ridge Nat Lab
- ◆ Rice University
- ◆ USITC
- ◆ Woodrow Wilson Center

Purpose



- ◆ Both the chemical industry and the semiconductor industry ESH sub-teams identified priority areas of research.
- ◆ To coordinate efforts the two teams agreed to develop a single list of recommended focus areas.

**Result: Identification of
5 Key ESH-Related Research Needs**

Key Research Needs



1. Testing Strategy for Assessing Toxicity
2. Best Metrics for Assessing Particle Toxicity
3. Exposure Monitoring Methodologies
4. Risk Assessment Methodology
5. Communication & Education Concerning ESH and Societal Impacts

Testing Strategy



Need:

- ◆ Standardized approach for evaluating nano-sized materials for mammalian and environmental toxicology.

Current Situation:

- ◆ Globally harmonized studies can serve as a basis:
 - ❖ OECD and EPA Testing Guidelines for Testing Chemicals
- ◆ BUT many limitations:
 - ❖ What is the best dose metric (weight/body weight)
 - ❖ How to administer nano-sized materials using a relevant exposures
 - ❖ What enhancements to the OECD protocols would be helpful
 - ❖ Proper characterization of test material
- ◆ Limited number of comprehensive toxicological safety assessments on newly development nano-sized materials.

Testing Strategy Recommendation



- ◆ Development of a screening/prioritizing strategy for the testing of nano-sized materials with the highest ESH concerns.

- ◆ Key factors to consider:
 - ❖ Production volume of nano-sized material
 - ❖ Exposure potential – occupational, consumer and environmental.
 - ❖ Physiochemical properties indicative of potential toxicity
 - ❖ Validation of available in-vitro and short-term toxicity assays

Best Metric for Assessing Nano-sized Material Toxicity



Need:

- ◆ Metric or set of metrics that accurately reflects the risk associated with exposure to nano-sized materials.

Current Situation:

- ◆ Dose (weight/body weight) may not be the best metric.
- ◆ Research has shown that other metrics may be more applicable.
 - ❖ Number of particles
 - ❖ Surface area
 - ❖ Surface charge
 - ❖ Surface chemistry

Best Metric Recommendation



- ◆ It is unlikely that a “one-size fits all” metric will be able to adequately address the broad range of nano-sized materials.
- ◆ Appropriate metrics may vary by media: air, water, solids, etc.

Recommendation:

- ◆ Further explore relevant metrics (size, surface characteristics, etc)
- ◆ Delivered-dose (concentration in bloodstream or at target site) metric should also be explored.

Exposure Monitoring



Need:

- ◆ Exposure monitoring methodologies to assess both occupational and non-occupational exposures to nano-sized materials.

Current Situation:

- ◆ Nano-sized materials may behave differently than larger sized materials.
- ◆ No standardized occupational exposure methodologies exist.
- ◆ Uncertainty over what parameter should be measured to quantify exposure (e.g. surface area, particle count, mass, degree of agglomeration)
- ◆ Industry studies underway to develop monitoring protocols and measurement devices for nano-sized aerosol particles.

Exposure Monitoring Recommendation



- ◆ Development of standardized exposure monitoring techniques and analytical methodologies.

- ◆ Key Factors to Consider:
 - ❖ Should incorporate work to define “best metric”
 - ❖ Should consider hazard and risk variables.

Risk Assessment Tool



Need:

- ◆ Development of an risk assessment tool to assess occupational and non-occupational exposures to nano-sized materials.

Current Situation:

- ◆ No published methodologies or standardized risk assessment tools.
- ◆ Current risk assessment tools may not be suitable for nano-sized materials due to toxicity and exposure unknowns.
- ◆ Limited information on nano-sized particle behaviors in air streams.
- ◆ Unknown exposure routes.

Risk Assessment Tool Recommendation



- ◆ Development of an risk assessment tool for nano-sized materials.

- ◆ Key Factors to Consider:
 - ❖ Potential risk based on toxicity of nano-sized material
 - ❖ In absence of toxicity data, what conservative, but reasonable measures can be taken to minimize risk?
 - ❖ Potential risk based on exposure to the material given the nature of its use (e.g. aerosol vs. aqueous solution)

Need:

- ◆ Open communication of benefits and risks associated with nanotechnology.

Current Situation:

- ◆ Opportunity and need to educate is NOW:
 - ❖ 70% of consumers “somewhat” or “very hopeful” about nanotechnology (NCSU, 2004).
 - ❖ 80% know “little” or “nothing” about nanotechnology (NCSU, 2004).
 - ❖ Studies suggest consumers will be influenced by mass media, likely toward the negative (UW, 2004)
 - ❖ Low trust in industry and government to get it right (WWIC, 2005)
 - ❖ Public wants to be included (WWIC, 2005)
- ◆ UC-SB recently funded as National Center for Nanotechnology in Society.

Communication/Education Recommendations



- ◆ Coordinate communication for ESH impacts, societal impacts and overall benefits of nanotechnology within the US.
 - ❖ Single voice – non-technical
 - ❖ Government should take lead, other groups can support (e.g. ICON database)
- ◆ Coordinate communication across international geographies.
 - ❖ ESH and Societal topics should not be competitive.
 - ❖ Ongoing communication and coordination needed.
- ◆ Conduct ongoing surveying/monitoring of public opinion.
 - ❖ Opportunity for international coordination