ICON International NanoEHS
Research Needs Assessment Goals

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NanoEHS Research Needs Assessment Goal

• The ultimate goal of this project is to prioritize research needed to establish a science-based assessment of potential risk of different classes of nanomaterials (both current & emerging) and to validate the classes of nanomaterials and the principles that relate properties to predicted risk factors.

• Workshop 1: Material Properties & “Hot Spots”
• Workshop 2: Research Needs & Priorities (Toxicology, Toxi-cokinetcis, etc.)
Background

- Multiple reports have identified concerns and research needed
- Hypothesis emerging on property effects on transport & bio-interaction
  - Size
  - Shape & Aspect Ratio
  - Chemical Reactivity
  - Surface Charge
  - Composition
  - Surface Composition
- International efforts to manage potential risk
  - IRGC, ASTM, ISO, ICON, etc.

Need Improved Understanding of Nanomaterial Bio-interactions
Proposed Generations of Nanotechnology

- All will use basic nanomaterial building blocks
- Frame 2 nanotechnology: designed functional performance

New nanomaterials will continue to emerge..
Nanomaterial Classes & Properties

**Nanomaterial Types**
1. Carbon Based
2. Metal based
3. Dendrimers
4. Composites

**Aquatic Classification**
1. Charge Neutral
2. Anionic
3. Cationic
4. Amphoteric

**Nanomaterial Properties to Monitor**
1. Size Distribution
2. Agglomeration State
3. Shape
4. Crystal Structure
5. Chemical Composition
6. Surface Area
7. Surface Chemistry
8. Surface Charge
9. Porosity

ILSI, Oberdorster, et. al. Principles for characterizing the potential human health effects from exposure to nanomaterials: elements of a screening strategy

• Need to establish nanomaterial classes
  • Based on properties that affect transport and biointeraction
Nanomaterial Characterization Challenge

- Characterize Bio-interactions of current and new nanomaterials
- Characterizing each nanomaterial appears to be overwhelming...
- Establish principles of physical/chemical property correlation with transport & bio-interaction.
ICON Nanomaterial Workgroups

- Oxide Nanomaterials
- Semiconductor Nanomaterials
- Metal Nanomaterials
- Carbon Nanomaterials
- Macromolecules (Dendrimers, etc.)
- Self Assembled Nanomaterials
  - Including the Self Assembly Process

These workgroups are providing a starting point for nanomaterials classes
Prioritize Research!!

- Nanomaterials in high volume with
  - High exposure dose potential
  - Long term exposure
  - Likely exposure pathways
- Nanomaterials with high potential toxicity
- Establish Classes of Nanomaterials
  - Physical/Chemical Properties that produce high toxic response
  - Identify screening test for the class
  - Validate the class with experiments
Enable a Hierarchy of Assessment

Research
Characterize Properties
Determine Class
Establish Safety Protocols

Manufacturing Development
Refine Class
Improve EHS Protocols

Product Development
Assess Product EHS Interactions

Product Applications

New nanomaterials will continue to emerge.
Characterization of Properties

- Size
- Shape & Aspect Ratio
- Chemical Reactivity
- Surface Charge
- Composition
- Surface Composition
Chemical Reactivity

Factors that could contribute:
- Electron Affinity
- Electronegativity
- Crystal structure
- Surface structure
- Surface composition

What property can be characterized that determines the chemical reactivity?
Is this affected by pH?

Linsebigler, Lu & Yates, Chem. Rev. 95, p735, 1995
Summary

- International need for improved understanding of nanomaterial EHS properties
- Establish Classes of Nanomaterials based on properties that affect bio-interaction.
- Prioritize Research
  - Nanomaterial Volume, Exposure
  - Toxicity
  - Validation of Nanomaterial Classes