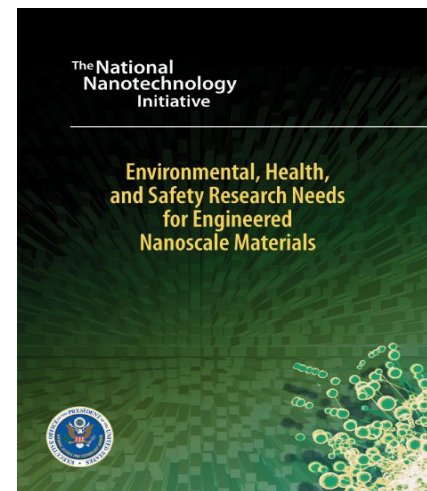




Instrumentation, Metrology, and Analytical Methods: Priority Research Needs

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Scope of Research

2. INSTRUMENTATION, METROLOGY, AND ANALYTICAL METHODS

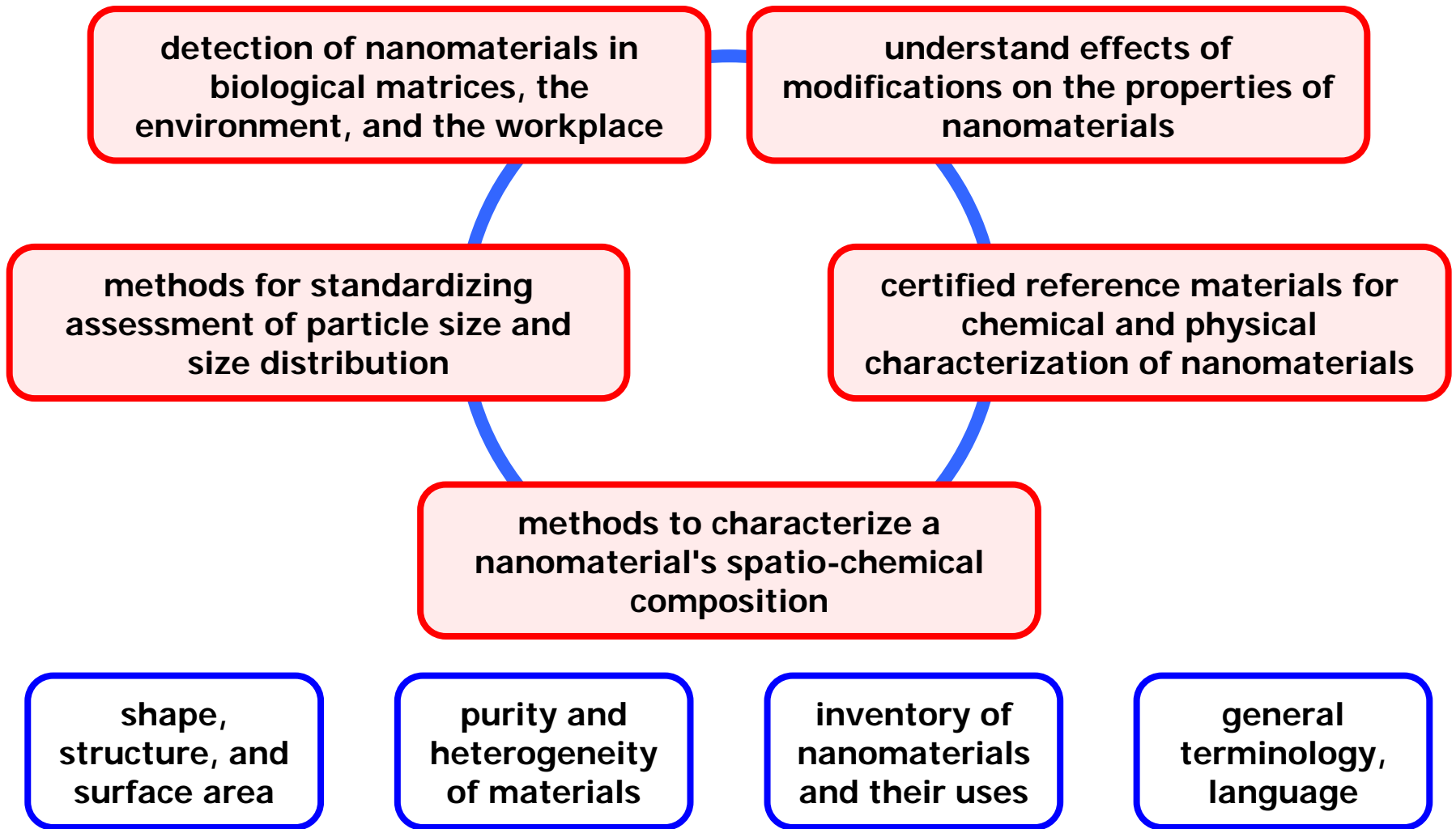
This area identifies research to enable new instrumentation and standard measurement protocols, as well as the development of reference materials and data related to the detection, characterization, and measurement of physical, chemical, and biological properties of engineered nanoscale materials in environmental and biological matrices (e.g., air, water, soil, cells, tissues, organs, organ systems, and whole organisms). Also addressed is the development of terminology, nomenclature, and standards for engineered nanoscale materials, a cross-cutting need for each research area discussed in this document.

● Research Needs focus on:

- ❖ instrumentation and standard measurement protocols, standard reference materials and data
 - detection and characterization
 - measurement of physical, chemical and biological properties
- ❖ environmental and biological matrices, workplace included
- ❖ terminology, nomenclature, and standards

General Background

Instrumentation, Metrology, and Analytical Methods





Research Need 1

Develop methods for detecting nanomaterials in biological matrices, the environment, and the workplace

● Scope

- ❖ evaluating nanomaterials requires knowledge of their nature and properties
 - amount and distribution
 - biological matrices, environment, and workplace
- ❖ validated assays are needed to detect nanomaterials and residues in tissues and animal, plant, and food-related matrices
 - critical for assessing associations between specific nanomaterials, behavior, and effects
- ❖ cross-cutting need that affects all of the research areas

● Rationale

- ❖ methods for detecting nanomaterials in the environment and in people are lacking, as well as methods for measuring effects
- ❖ in cases where methods are available, limitations and specifics within the various matrices have not been addressed



Research Need 2

Understand the effect of modifications on the properties of nanomaterials

• Scope

❖ **surface modification of nanomaterials contributes to:**

- toxicity, biocompatibility
- dispersion and agglomeration (also influence toxicity)
- possible changes in behavior
 1. degradation or uptake by biological matrices
 2. usefulness of the material (efficacy)

❖ **modifications may affect measurement methods**

• Rationale

❖ **unclear how modifications effect biological matrices**

- testing modified materials challenging

❖ **existing methods for the determination of the chemistry of materials may need to be modified or enhanced**

- procedures may change with given modifications



Research Need 3

Develop methods for standardizing assessment of particle size and distribution

● Scope

- ❖ important for understanding nanoparticle toxicity
- ❖ accurate sizing needed to understand amount and number

● Rationale

- ❖ current methods for sizing particles below 10 nm inadequate
- ❖ rapid sizing methods, although indirect:
 - assist with process and waste stream monitoring
 - produce population-based sizing
- ❖ microscopy methods, although direct:
 - lack sufficient throughput
 - fail to provide population-based sizing
- ❖ severe lack of correlation studies between derived and direct measurement methods
- ❖ size parameter definition and terminology unclear at present

Research Need 4

Develop Standard Reference Materials for chemical and physical characterization of nanomaterials

● Scope

- ❖ homogeneous, stable materials well characterized
- ❖ essential to developing validated characterization methods
- ❖ materials widely used for research applications
 - evaluation of sampling devices, instruments, or protective gear
 - toxicity studies
- ❖ necessary for all research needs in this topical area

● Rationale

- ❖ few nanoscale reference materials are available
 - ones that are available may not be relevant to environment, health, and safety research needs for nanotechnology
 - simple and complex materials lacking
- ❖ use of reference materials assists with comparison of results
 - assessment of quality and comparability of performance



Research Need 5

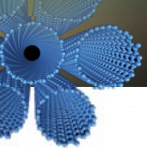
Develop methods to characterize a nanomaterial's spatio-chemical composition

• Scope

- ❖ critical to address other research needs
- ❖ critical to understanding and predicting various aspects of nanomaterials
 - toxicology, reactivity, and dynamics
 - modifications
 - properties and behavior (biological and environmental)
 - impurities and defects (quality control)

• Rationale

- ❖ most chemical analytical techniques designed for bulk materials
 - lack spatio-chemical resolution necessary to resolve differences in composition at the nanoscale
- ❖ approaches to characterize the chemical nature of nanomaterials are challenging and not well-developed



Conclusions

- Is the breadth of this research category captured by the research needs identified?
- What criteria should be considered in setting research priorities?
- Which research need(s) should be prioritized within this category?
- Additional comments?