



**ANSI-Nanotechnology Standards Panel  
Break-out Group Report**

- 1. Name of Break-out Group:** Inorganic Nanomaterials
- 2. Date of Report:** September 30, 2004
- 3. Scope of Break-Out Group:** Nomenclature standardization for inorganic nanomaterials, implementation, cross-cutting issues, and broader issues
- 4. Facilitator:** Jake Reder (Cabot Corp)
- 5. Recorder:** Tom Mallouk (Penn State)
- 6. Break-out Group Participants:** **Append a list of participants in the discussions.**

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These issues and questions are posed specific to the scope of this break-out group.

I. Brainstorming session related to nomenclature standardization

*Break-out group members should develop and prioritize on a scale of 1-10, 10 being most urgent, the top three to five issues with respect to the following question:*

1. What are the most critical nomenclature issues that require discussion and resolution?

This brainstorming session resulted in a large number of suggestions which were then grouped into four categories: (1) static structure, (2) composition, (3) properties – which were sub-grouped into chemical, biological, and physical, and (4) metrology and means of measuring properties.

The consensus of the group was that the composition and static structure categories are most important for nomenclature; if we a good job here, the properties (which give rise to interesting science and applications) should follow reproducibly.

Through individual voting (five votes per panel member were allowed) and subsequent discussion, the group agreed that the most critical issues for nomenclature are *morphology, size, composition, and crystallinity*. The full listing of categories with the number of votes for each (in parentheses) are given below:

Static Structure

Morphology (7)

Size and size distribution (6)

Surface structure

Crystallinity, crystal structure, degree of order, defect and grain structure, grain size (5)

Porosity

Superstructure/structural hierarchy/aggregation (2)

Composition

Chemical formula/mineral name (6)

Core (1)

Impurities, dopants, defects, level of purity

Solid solution

Surface composition: shell, coating, etc. (1)

Properties

*Chemical* (5)

Reactivity

Degradation, corrosion, stability

Solubility

Chemical transport

Metastability

*Biological* (4)

Environmental (1)

Medical, human toxicological(2)

Biocompatibility

Toxicity – Neurotoxin, organ (pulmonary, hepatic), systemic

Respirable, transdermal – transport route of entry

*Physical* (3)

Optical, electronic, magnetic

Mechanical (stress/strain)

Mechanical abrasion and wear (2)

Thermal

Failure modes, fracture morphology

Metrology – Means of determining properties

Methods of characterization

Measurement – dynamic vs. static, measurement in industrial environment

- II. Discussion of implementation questions
  - 1. What standards work is underway; who is involved and is any group or individual considered the “leader”?
    - i. Domestic
    - ii. International
    - iii. Regional

This breakout group was aware of the following related standards work:

IEEE started an effort last Nov. (here at NIST) – electrical conductivity of carbon nanotubes  
NIST - comparison of methods for measuring particle size, standard reference materials  
Academic – Journal editors are “gatekeepers” of new nomenclature, seminal papers introduce new terminology (e.g., porous materials, CNT’s).  
NIOSH, EPA – Getting ready to enact guidelines for best practices, need nomenclature first.  
ASME – Surface texture (1 chapter on nano)  
ASTM – Carbon black, standards initiative including nomenclature, first meeting soon.  
NPL (national physical lab) – property testing  
IUPAC - ?  
Japan: NMIJ (nat’l metrology institute of Japan)  
UK – RSC paper  
Germany – BMG? Standards for length measurement

- 2. Are any stakeholders missing from this group?

IUPAC  
Leading academics  
Global (AP, EU)  
SIA/Sematech/SRC  
Professional societies, e.g., AAAS, ACS, MRS, TMS  
Non-Ph.D. public (e.g., LOKA institute, CPSC)

- 3. Are there any cross-cutting issues with other break-out groups? If so, please identify.

Our top 4 categories (*morphology, size, composition, and crystallinity*) are relevant, especially to groups 1 and 3

- 4. What are the possible impediments to the generation and acceptance of a universal nomenclature?
- 5.

Too many stakeholders  
Inertia – Don’t propose something too radically different from terms that are now in use.  
Existing IP mess, trademark issues  
Cost of meetings and education

6. Provide recommendations on appropriate venues in which to address the needs identified and any individuals or organizations who should be contacted to serve as project leaders.

Venues

Existing conferences: NNI (April mtg), trade groups, Nanocommerce

Special meeting

Media – Position paper

Individuals

Industry

Government

III. Brainstorming broader issues of nanotechnology standardization needs

*Break-out group members should develop and prioritize on a scale of 1-10, 10 being most urgent, the top three to five issues with respect to the following questions:*

1. Are there other areas in nanotechnology that would benefit from standardization? If yes, please identify the top 5.
2. Are there stakeholders in these areas that should be involved in future discussions? Please identify.

IV. General Comments

1. Comments/observations/suggestions
2. Thoughts on next steps
3. Is there a need for a future meeting of this break-out group?

Recommendations

- We agree that the development of a general nomenclature system for nanostructures and nanostructured materials is timely and highly desirable.
- We recommend a nomenclature system that incorporates morphology, size, composition, and crystallinity as a minimum, with ranges of each.
- We recommend combining carbon and other inorganic nanostructures in a common nomenclature system.
- We recommend exploring the possibility of designing compatible nomenclature systems for inorganic, polymer/organic, and hybrid nanostructures.

- Appendix: Breakout Group Participants

Jake Reder (facilitator)

Bob Scace.

Jason Hertzberg

Albert Davidov

John Koehr

Bill Buhro

Stephen O'Brien

Bob Shull

Willfred McCain

Tom Mallouk (scribe)