ANSI-Nanotechnology Standards Panel
Break-out Group Report

1. Name of Break-out Group: Carbon Nanostructures

2. Date of Report: September 29, 2004

3. Scope of Break-Out Group:

4. Facilitator: Dr. Kevin Ausman

5. Scribe: Tracy Hester

6. Break-out Group Participants: Append a list of participants in the discussions.

Part 1: Critical issues for terminology/nomenclature that require discussion and resolution

- 12 Physical dimensions (e.g., inner/outer diameters, etc.); Polydispersity (10)
- 10 Hierarchy of structure/fractal dimension; Dispersion/state of aggregation (9)
- 9 Surface Features (reactivity, functionalization, structure/porosity, surface area) (8)
- 7 Consideration of existing nanomaterial terminologies; Types of carbon nanostructures (taxonomy of recognized types); Historical/Legacy carbon materials (carbon black, diesel exhaust, filtration carbon) (7)
- 7 Universality of nomenclature systems beyond carbon; what is already used; synonyms (7)
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- 6 What's in there besides carbon? Defect density/types
- 5 What is "in" the class of nanomaterials? Is one dimension enough?
- 3 Measurement and Consequences on observed parameters
- 1 How different is different?
- 0 Covalent vs. noncovalent
- 0 Mixtures/composites
- 0 Ditch the term "nano"

Discussion of Implementation Questions:

1. What do we already know about standards work in the nano area in general and in carbon structures?
    a. IEEE standard for carbon nanotubes for electrical characteristics
    b. Both IUPAC and CAS have well-established nomenclature systems for fullerenes. Don't want to create a third unless this group has a recommendation otherwise.
    c. European Nanobusiness Association – initiative includes efforts on metrology and terminology, 9/04
    d. CMP slurry by SEMI (track down Bob)
    e. Carbon black nomenclature and standards – ASTM has a two-dimensional classification (size & structure).
    f. ASTM meeting on Friday – on same topic.
    g. ASME has metrology efforts underway.
2. What stakeholders are missing from this process? Both with respect to carbon issues as well as larger nano effort?
    a. Nomenclature/Terminology
        i. OSHA/NIOSH in the carbon group
        ii. Current producers and users of carbon nano materials (cosmetics, carbon black)
        iii. International parties (IUPAP/IUPAC; Japan)
        iv. ISO
        v. Royal Academy of Sciences/German study
        vi. Public interest community
        vii. Health community
        viii. Clean room industry (IEST)
    b. .
3. Application of nomenclature system for carbon nanomaterials to inorganic nanomaterials?
    a. Once you're looking characteristics beyond the individual particle, the characteristics remain largely the same for larger structures.
    b. Universality of nomenclature should therefore be encouraged wherever possible.
    c. At the individual particle level, ….
4. What are the possible impediments to universal acceptance of nomenclature or terminology?
    a. Differing scientific disciplines
    b. International and geopolitical climate
    c. Costs
    d. Higher priorities
    e. Strong commercial reasons (can go either way)
    f. Protection of confidential business information (e.g. – polymer industry protection of production information in commodity market)
    g. Patents and IP protection
    h. Acceptance by academics

   i. Concerns about regulatory impacts (absence of regulatory standard also a disincentive, however)
   j. Labeling concerns
5. Recommendations for venues to address these needs, or individuals or organizations to contact to act as leaders in the nomenclature/terminology generating effort?
   a. Need volunteer expert leaders in field, and critical mass of participants to support effort. Also need some working documents to start with.
   b. ASTM
   c. IEEE
   d. AIHA
   e. Factors to consider: expertise, credibility, specific subject matter expertise (no nano-SDOs now). Group can be small, given limited size of production community.
6. Inorganic Group – compared ideas
7. Broader areas of nanotechnology standardization needs
   a. Are there other areas of nanotechnology that would benefit from standardization other than nomenclature or terminology?
      i. QA/QC of manufacturing processes
      ii. Whole range of metrology
      iii. Standardized toxicity testing, EH&S
      iv. Workplace safety standards
      v. Environmental dispersion
      vi. Environmental and ecological risk assessment
   b. Note: when discussing alternative formats for future standards work (all stakeholders in one group; separate stakeholders; and hybrid), the industrial producers elected for separate workgroups while SDOs/academics preferred a hybrid approach.
      i. If groups were separate initially but then rejoined towards end of process, might help reduce some concerns.
      ii. Larger groups may lead to lengthy delay if consensus must ultimately be reached. Collegial approach may help minimize this effect.
      iii. Inefficiency grows as focus becomes more tightly focused, and may need to separate groups at that point.
      iv. Need flexible structure to accommodate fast-moving developments in field.
      v. Timing issue – other examples where differing solo vs. hybrid approaches were tried, and effects on time required to reach results?
         1. Closer you get to people who really need to implement, the better off you are.
         2. Alternatively, consumer decisions driven by product and outcomes, not underlying yet unapparent factors (e.g., enzymes). Start from the utility aspect, and work backwards as time and technology allow you to do so.

3. Remember nanotechnology is not an industry – users actually in different industries. When you set standards in a technology like that, what problems arise?

c. Sidenote – with a straw poll vote on which subgroup members would participate in a standards setting effort for carbon, a high percentage said yes.
d. Are there stakeholders in these areas that should be involved in future discussions? Please identify.

8. General recommendations to guide next steps:
   a. Carbon nanostructures would benefit from a standardized nomenclature. The urgency of this need was open to dispute among the stakeholders.
   b. When working with the inorganic nanostructures group, consensus that hybrid umbrella group approach offers best approach if risks of delay can be minimized (subject to concerns raised by producers).
   c. Canvas all potential organization sources for existing terminology or nomenclature.