

# Measurement Needs

- In situ measurement tools
- Specification of materials for specific applications
  - Properties and definitions thereof
- Standardized measurement methods
  - Measurements that are proven to be appropriate and “fit for purpose”
    - For mixed production processes, specify key characteristics of needed NM properties
  - Identify priorities – which methods should we concentrate on first
    - Determine “quality” needed – how much is enough
- Measurements for toxicity testing

# Framework

- Tiered approach - different levels of standards should be considered depending on exposure route and exposure level (incidental, medical)
- Obviously, nanomedicines must go through very rigorous processes and regulatory procedures that are dictated by country

# Documentary Standards Needs

- Short term (less than 2 years)

## **WHAT DO WE NEED?**

- Protocols for pharmacokinetics - ADME Tox (absorption, distribution, metabolism, excretion) - high priority in OECD
- Define a minimum set of measurements - size, zeta potential (surface charge), solubility - predictor of toxicity?
- Particle characterization protocols for nanohealth - ones that take into account the biological coating (MALDI, SIMS)
  - Methods for analysis of surface conjugated layers
- Toxicology screening tests - good or bad for human health
- Methods to determine NM stability in biological matrices
- Standards for delivery for NMs - route of exposure

## **HOW CAN THIS BE ACCOMPLISHED?**

- Most should be Publicly available specification or technical report in short term to support community with best practices

# Measurement Needs

## Existing methods/tools

- Many disparate efforts, NCI-NCL laboratory specifically for nanohealth applications (from characterization through in vivo)

## New methods/tools needed for:

- Surface stoichiometry (ratio of proteins adsorbed)
- Surface biofunctionality (bioactivity)
- Epitope map (mapping small units of peptides with bio activity)
- In vivo imaging of NMs
- In vivo measurements of distribution
- Cross imaging modalities (modeling)

## New Tools needed in:

- Separation science
- Modeling
- Imaging (CARS, Neutron imaging, attosecond science for tomography at nm scale)

# Documentary Standards Needs

- Identify MNP characterization measurands including those corresponding to OECD Endpoints. 7
- Standard method to disperse solid nanomaterials in aqueous solutions – protocol for use of surfactant for liquid dispersion. 5
- Standardized method for sample preparation for in vitro and in vivo toxicity testing including use and application of surfactants 4
- Check applicability of standard P-chem analytical methods for MNP 3

# Documentary Standards Needs

- For raw materials
- For process control/quality
- Performance measures
- Practice guides/guidance documents (near term)
  - On what information is needed when handling/using nanoparticles
  - On sample preparation, stability considerations, surface analysis, etc.
- Means to classify or “grade” nanomaterials so users can make informed decisions about what they are purchasing (fit for purpose, good enough)
- Guidance document on suite of measurement techniques that go together and the information the combined data set may provide
  - What measurement techniques are applicable what their limitations

# Factors driving standards

- Life Cycle Concerns: From Concept to End of Life. How will nano-enhanced electronics be disposed?
- What should be specified? What should be measured?
- Understanding nanoscale driven failure/success modes
- Multi-committee sponsorship
- Education/Communication readily accessible
- Need more source information that is driving nano-enabled products.
- Non-tariff technical barriers to trade (e.g. WTO)

# Measurement Needs

- New tools/techniques needed
  - Contactless measurements
  - Non-destructive techniques
  - Framework for validation of embedded nano-enabled product claims

# Application fields

## Physical/ Chemical parameters to be measured

	Size	Shape	Thickness	Surface/Interface comp.	Comp. Purity	Solubility	Adhesion
Photovoltaic	x	x	x	xx	x		x
Energy/Batteries	x	x	x	x	x		
Emulsion/Surfactant	x			x	x	x	
Catalysis	x	x		xx	x		
Corrosion inhibitors			x	x		x	x
Quantum dots	xx	x		x	x		x
Filters	x						x
Films Coating			x	x	x		xx
Fillers		x		x	x	x	x
Paints/Coatings	x		x	x	x	x	xx
Composites	x	x	x	x	x		x
Sensors			x	x			
Cosmetics	x	x		x	x		
MEMS/NEMS			x	x			x
Concrete	x	x			x		
	ISO/TC24/T C201, ASTM/E29	ISO/TC24, TC201, ASTM E29	ISO/TC202	ISO/TC201, ASTM/E42			ISO/TC206

# Documentary Standards Needs

- Short term (less than 2 years)
  - Take IEEE NESR to the next level
  - What do we do with existing nano-enabled products on or entering the market? (e.g. nano-enabled batteries)
  - IEC TC-113 Framework Survey
  - Coordination of SDOs involved in nanoelectronics standardization.
- Medium term (2-5 years)
  - Crystal ball is cloudy!
- Longer term (>5 years)
  - What crystal ball?

# Practical actions – fundamental property characterization

- Need for several guides identified:
- Practice guides/guidance documents (to include EHS issue consideration) on
  - what information is needed when handling/using nanoparticles
  - suite of measurement techniques that go together and the information the combined data set might provide (what measurement techniques are applicable and what are their limitations);
  - Sample preparation for characterization, including consideration of dispersion and aggregation/agglomeration;
  - Sample preparation for toxicology testing;
  - Stability considerations relevant to manufactured nanomaterials;
  - Application and limitation of surface analysis to nanoparticles;
  - Expression of concentration and dosimetry.
- Who will produce and on what timescale?

# Freely accessible and searchable terminology database

- ISO have a mechanism – “concept database” designed precisely for this.
- Any other offers?

# Database of information on existing and newly developing standards for nanotechnologies

- Propose that this is assembled and maintained by NIST

# Key Themes

- Existing relevant information
- Prioritization of measurement needs
- Terminology
- Who does what?
- Progress and feedback

# Communication Mechanisms

- Combine resources of different committees and organizations to address cross cutting issues
- Permanently updated discussion forum to align information and developments from the different SDOs
  - Should include existing standards and NWIs
- Database of existing measurement tools and new tools needed
- Definitions (terminology) from all sources in a searchable database, freely available
  - May need to define new terms (dustiness, for example)
  - May need to construct an agreement amongst the various parties to make terminology available in one document

# Coordination of (ISO) activities

- Liaison structure in place – need the mechanism!
- TC229 liaisons with TC24, TC146, TC194, TC201, TC202, TC209, TC213, IEC/TC113 and OECD
- Participation of many relevant NMIs through National participation in TC229
- Propose forming a “Nanotechnologies Liaison Coordination Group”, which will meet formally together at each TC229 plenary week
  - Proposed membership: liaison officers from each TC and/or relevant SC, liaison from regional NMI’s, liaison from OECD WPMN, convenors of TC 229 WGs, 229 chair and secretary
  - Proposed terms of reference: to coordinate and harmonize the work of relevant TC’s in the field of nanotechnologies and to identify cross cutting gaps and opportunities and ways to resolve these.