CANADIAN STANDARDS ASSOCIATION

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ISO and IEC Standards for Nanotechnologies

NGC 2009, Nano and Giga Challenges in Electronics, Photonics and Renewable Energy, and

CSTC 2009, 14th Canadian Semiconductor Technology Conference

August 10 - 14, 2009
McMaster University, Hamilton, ON, Canada

Brian Haydon, P.Eng.
Administrator for Canada's national committee for ISO/TC229 and IEC/TC113

Topics

- Standards – ISO and IEC
- Standards for Nanotechnologies
- ISO/TC229
- IEC/TC113
- Standards Development Work Items
- Become involved in Standards

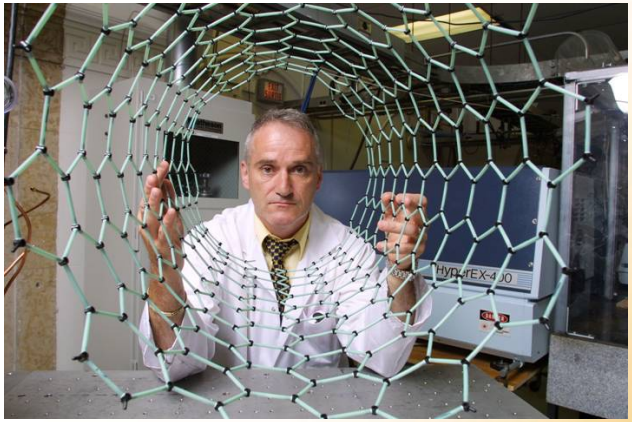

Photo courtesy NRC-SIMS
National Research Council Canada
Steacie Institute for Molecular Studies

Written Standards

- **Provide agreed ways of:**
  - Naming, describing and specifying
  - Measuring and testing
  - Managing e.g. quality and environmental management: ISO 9001 and ISO 14000
  - Reporting e.g. proposed ISO 26000 (Social Responsibility)

- **International Standardization Organization**

  Non-governmental organization of some 148 national standards bodies and 550 international or regional liaison bodies.

  Delegates nominated by national standards bodies or liaison organizations develop ISO standards through a rules and consensus-based process.

  ISO standards are voluntary.

- **International Electrotechnical Commission**

  Leading global organization that prepares and publishes international standards for electrical, electronic and related technologies.

  IEC standards are voluntary.

Nanotechnologies

- Nanotechnology is being applied globally, to meet specific needs in new products, materials, systems, and processes and will impact many areas, including medical, forestry, construction, transportation, agriculture/food, electrical/electronics and materials.

Use of standards

- The development of standards will support research, commercialization and trade in materials and products at the nanoscale, stimulating growth through the commonality of metrics and terminology.

- These standards will also support the development of appropriate national and international regulations, including guidance documents.

- These regimes will provide certainty and confidence for workers, consumers, manufacturers and users alike.

Standards as change agents

- Many of the documents produced will be anticipatory (developed ahead of the technology that act as “change agents” and guide the market).

- Nanotechnology is still in the early stages of development and evolution.

Overview of world activities in nano-standards development

- Major international Standards Developers in nano-related standards:
  - ISO, IEC, ASTM, IEEE
- Majority of countries
  - relying mainly on international development of nano-standards
- Some countries provide starting national documents:
  - BSI (UK) has fed national work into the int'l forum
  - China feeding selected national work into int'l forum
  - Taiwan, Korea, and others too

Nano-standards work is underway

There are over 30 active nano-related standard development work items underway at ISO and IEC:

- **Technical reports -** informative compilation of current knowledge and best practices
- **Technical specifications –** consensus on technical matter that is still evolving
- **International standards –** normative requirements with international technical approval

Standards for Nanotechnologies - ISO

ISO/TC229 Technical Committee
Nanotechnologies

formed in 2005 Chair: UK; Secretariat: UK

JWG1: **Terminology and Nomenclature** (Canada convenor)
JWG2: **Measurement and Characterization** (Japan convenor)
WG3: **Health, Safety and Environment** (USA convenor)
WG4: **Material Specifications** (China convenor)

ISO/TC229 Country Members

Participating Countries

Argentina
Australia
Austria
Belgium
Brazil
Canada
China
Czech Republic
Denmark
Finland
France
Germany
India
Iran, Islamic Republic
Israel
Italy
Japan
Kenya
Korea, Republic of
Malaysia
Mexico
Netherlands
Norway
Poland
Russian Federation
Singapore
South Africa
Spain
Sweden
Switzerland
UK
USA

Observing Countries

Egypt
Estonia
Hong Kong, China
Ireland
Morocco
Slovakia
Thailand
Venezuela

ISO TC229 objectives

- Support the sustainable and responsible development of nanotechnologies,
- Facilitate global trade in nanotechnology-enabled products and systems,
- Improve quality, safety, security, consumer and environmental protection, together with the rational use of natural resources,
- Promote good practice in the production, use and disposal of nanomaterials and nano-enabled products.

Standards for Nanotechnologies - IEC

IEC/TC113 Technical Committee

Nanotechnologies - Electrical & electronic products and systems

formed in 2006 Chair: USA; Secretariat: Germany

JWG1: **Terminology and Nomenclature** (Canada convenor)

JWG2: **Measurement and Characterization** (Japan convenor)

WG3: **Performance Assessment** (Germany convenor)

IEC/TC113

Nanotechnology standardization for electrical and electronic products and systems

- standardization of components, intermediate assemblies, products, and systems created from nano-scaled materials and processes,
- attention to properties and functions electrical or electro-optical in nature,
- including assessment of performance, reliability, and durability in support of continuous improvement at all stages of the value adding chain.

Nano-standards development

- ISO/TC229 meets twice a year (since 2005).
- IEC/TC113 meets once a year, every other meeting jointly with ISO/TC229.
- More use of Internet-based teleconferencing and email correspondence to advance work between in-person meetings.

Nano-standards development

- Work items follow a defined, internationally-accepted standards development process.

- Volunteer experts participate

  – to openly discuss, develop, and draft science-based documents,

  – to comply with the scope and intent of each work item,

  – to reach consensus.

Areas for standards development

- Terminology
- Nomenclature
- Tools and Measurements for Characterization
- Toxicity/Hazard Potential
- Risk Evaluation Framework
- Occupational Exposure
- Environmental Protection
- Product Safety
- Commercialization and Trade

First standards completed in 2008

TECHNICAL SPECIFICATION

ISO/TS 27687

First edition
2008-08-15

Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate

Nanotechnologies — Terminologie et définitions relatives aux nano-objets — Nanoparticule, nanofibre et nanoplat

Reference number
ISO/TS 27687:2008(E)

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TECHNICAL REPORT

ISO/TR 12885

First edition
2008-10-01

Nanotechnologies — Health and safety practices in occupational settings relevant to nanotechnologies

Nanotechnologies — Pratiques de sécurité dans les arrangements professionnels relatifs aux nanotechnologies

Reference number
ISO/TR 12885:2008(E)

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ISO/TC229 & IEC/TC113 JWG1: Terminology and Nomenclature Work Items

1	**Terminology – nano-objects – nanoparticle, nanofibre and nanoplate** (Technical Specification published by ISO Aug. 2008)
2	**Terminology framework**
3	**Terminology - carbon nano-objects**
4	**Terminology – core terms**
5	**Terminology – nanostructured materials**
6	**Terminology – bio-nano interface**
7	**Terminology – medical, health and personal care**
8	**Terminology – measurement/instrumentation**
9	**Terminology – nanomanufacturing processes**
10	**Framework for nomenclature model for nano-objects (new work item proposal)**

Terminology

- Develop a base of terminology and definitions for nanotechnologies for effective communications;

- Provides common language for
  - effective communications,
  - classification work,
  - toxicity analysis,
  - health studies, and
  - trade among nations.

Sample terms being defined

Published definitions in 2008:

- nanoscale
- nano-object
- nanoparticle
- quantum dot
- nanoplate
- nanofibre
- nanorod
- nanotube
- nanowire

Other definitions soon to be published

- fullerene
- nanocone
- nano-onion
- nanoribbon
- carbon nanotube
- single-wall carbon nanotube
- multiwall carbon nanotube
- carbon fullerene
- carbon nanofibre
- graphitic nanofibre
- carbon nanohorn
- carbon nano-onion
- carbon nanopeapod
- carbon nanoribbon
- cup-stack carbon nanotube

and more definitions to come

Nomenclature

- Naming system for nanomaterials for regulatory, commercial and research needs:
  - means to differentiate amongst nanomaterials,
  - allow correlation of hazards,
  - contribute to workplace safety, protect human health and the environment, and
  - support communications.

ISO/TC229 & IEC/TC113 JWG2: Measurement and Characterization Work Items

1	**Use of TEM for Single Wall Carbon Nanotubes (SWCNTs)**
2	**Use of scanning electron microscopy (SEM) for SWCNTs**
3	**Use of near infrared-photoluminescence/ fluorescence for SWCNTs**
4	**Use of ultraviolet-visible-near infrared absorption for SWCNTs**
5	**Measurement methods for Multi-wall Carbon Nanotubes (MWCNT)**
6	**Use of Raman spectroscopy for SWCNTs**
7	**Use of evolved gas analysis/chromatograph mass spectrometry-SWCNTs**
8	**Use of thermo gravimetric analysis (TGA) for SWCNTs**
9	**Guide to nanoparticle measurement methods and their limitations**
10	**Measurement methods for MWCNTs**
11	**Guide to methods for nanotribology measurements**
12	**Meso-scopic shape factors for MWCNTs**

Tools and Measurements for Characterization

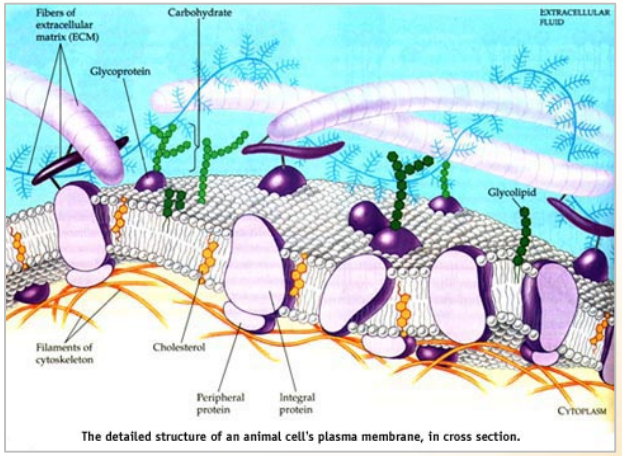
- Standards for measurement, characterization and testing
  - including metrology and reference materials to support industry and commerce,
  - test methods for toxicity and risk assessment,
  - measurements of properties and calibration for useful and accurate exchange of information,
  - globally-based test methods to enhance optimal movement of products among trading countries.

ISO/TC229 WG3: Health, Safety, and Environment Work Items

1	**Health and safety practices in occupational settings relevant to nanotechnologies –** Technical Report published by ISO Oct. 2008
2	**Endotoxin test on nanomaterial samples for in vitro systems**
3	**Generation of nanoparticles for inhalation toxicity testing**
4	**Monitoring nanoparticles in inhalation exposure chambers for inhalation toxicity testing**
5	**Guidance on physio-chemical characterization of engineered nanoscale materials for toxicologic assessment**
6	**Guide to safe handling and disposal of nanomaterials**
7	**Nanomaterial risk evaluation framework**
8	**MSDS for nanomaterials**

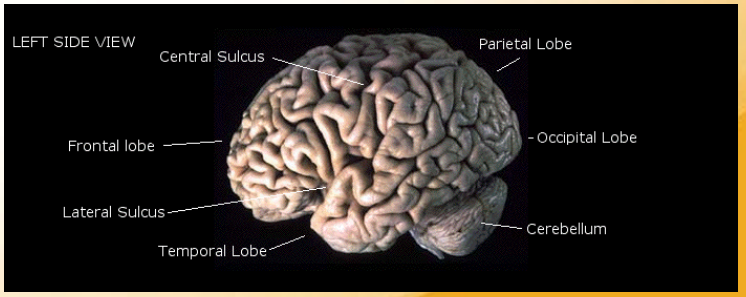
Health Concerns

- Evidence suggests that because of their small size, nanoparticles are able to cross cell membranes and interact with sub-cellular structures (NIOSH, 2006)



The detailed structure of an animal cell's plasma membrane, in cross section.

- Evidence that nanoparticles can cross the blood brain barrier via the olfactory nerves



Toxicity/Hazard Potential

- Physio-chemical parameters of nanomaterials need to be characterized to address
  - relative toxicity/hazard potential,
  - toxicological assessment methods, and
  - screening techniques/tests.

Guidance on physio-chemical characterization for toxicologic assessment

One ISO/TC229 WG3 work item:

Identify physical and chemical qualities of nanomaterials that may have an impact on toxicology of nanomaterials,

1. Agglomeration state/aggregation/ surface area
2. Composition
3. Particle size/size distribution
4. Purity/Impurity
5. Shape
6. Solubility
7. Stability
8. Surface chemistry
9. Surface charge

Liaison among WGs

WG 3 of ISO/TC229

JWG 2 of ISO/TC229 and IEC/TC113

Risk Evaluation Framework

- A risk evaluation framework for nanomaterials
  - for common application among countries, thereby reducing potential barriers to trade,
  - to ensure risk evaluation criteria has been met.

Occupational Exposure

- Development of health and safety practices for nanotechnologies.

- Effective controls for the workplace, where needed, documented in standards to address risks

  – through engineering techniques,
  – administrative means, and
  – if necessary, personal protective equipment.

Precautionary approach

- No current threshold limits for materials
  (BSI and NIOSH have attempted to make some recommendations)

- ‘Precautionary Principle’
  - No information, no risk assessment yet
    - take all precautions reasonable
    - err on the side of caution

Control Strategies

Lab Hood

Local Ventilation connected to Hepa Filter

Respirator

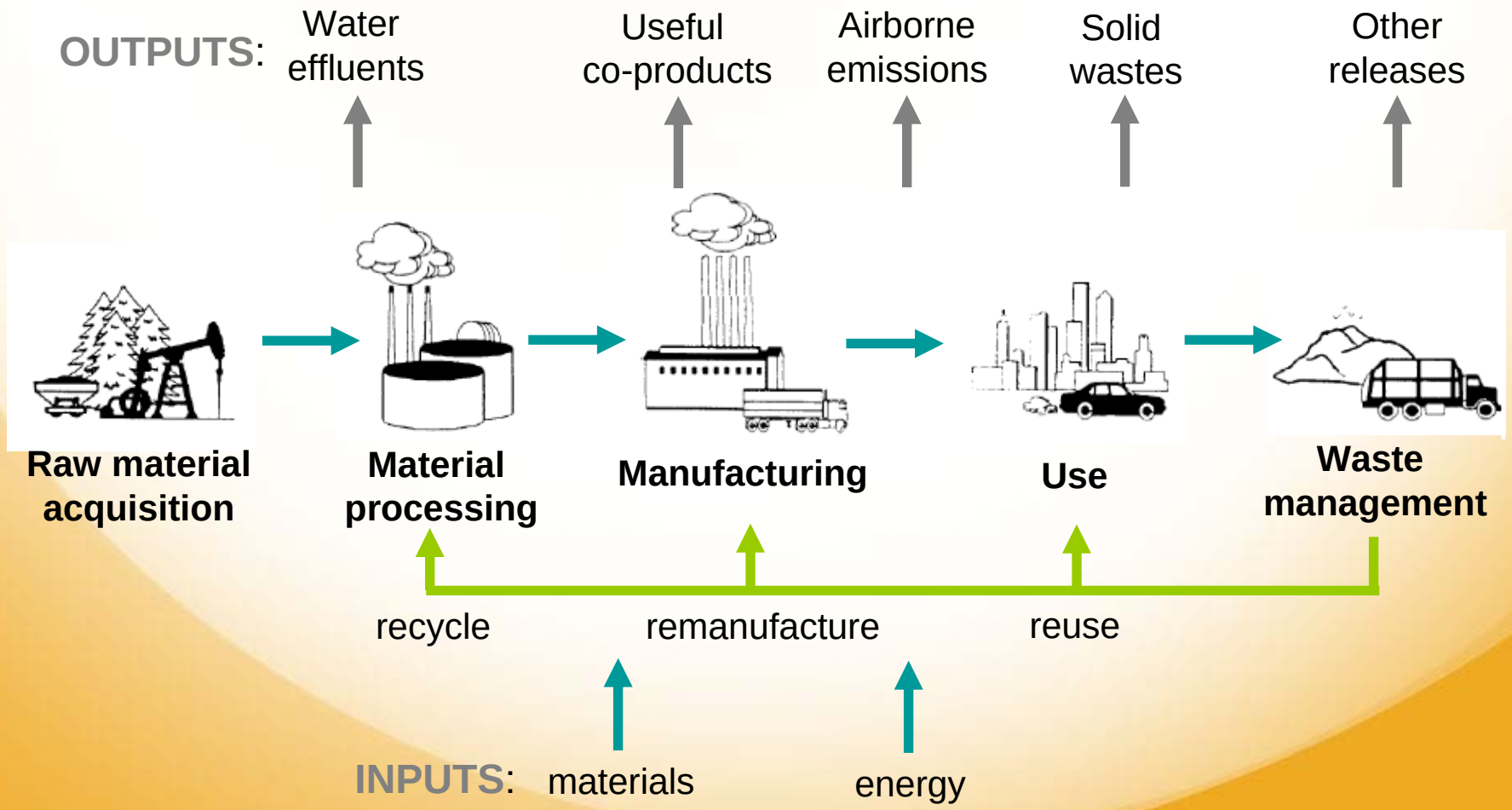
Glove Box

Environmental Protection

- Standards to refine and strengthen the link between physico-chemical properties of nanomaterials and the physical world interaction.

- Providing protocols, procedures and guidance to prepare, disperse, use and dispose of nano materials and nano-enabled products.

Production Life-Cycle



ISO/TC229 WG4: Material Specification Work Items

1	**Nano-calcium carbonate**
2	**Nano-titanium dioxide**
3	**Guidance on specifying nanomaterials**
4	**Guidance on labelling of manufactured nanoparticles and products containing manufactured nanoparticles**

Possible future work items for:

- Nickel
- Zinc Oxide
- Silicon Dioxide
- Cadmium Sulfide
- Quantum Dots
- Carbon nanotubes
- and other materials or generic groupings of materials

Product Safety

- Standards for
  - quality
  - safety

to assist the development of market confidence in new and improved products.

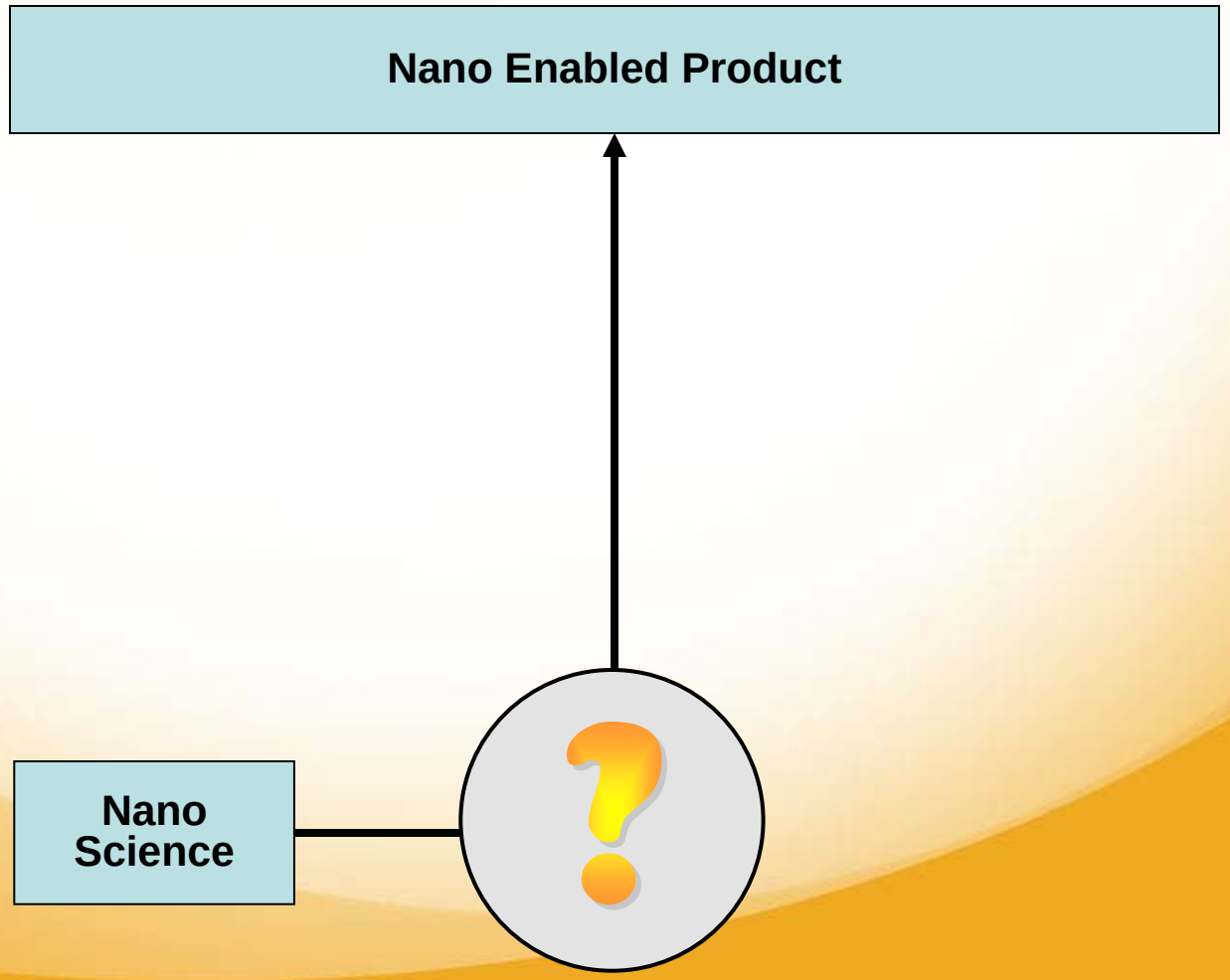
Commercialization and Trade

- Standards for materials and products in specific applications to identify
  - characteristics of materials and processes,
  - assess performance, reliability, and durability.

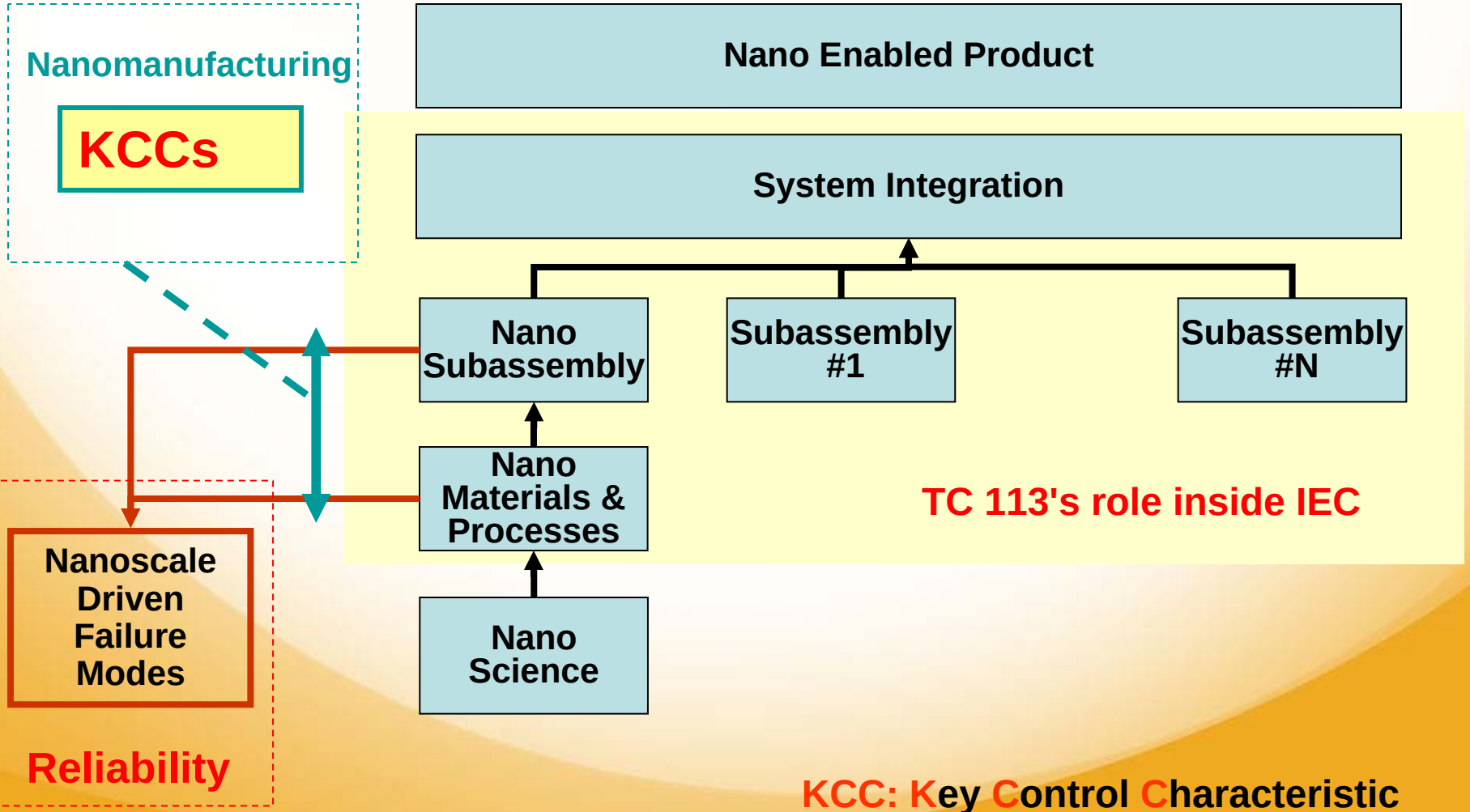
- To ensure compatibility (comparability) between materials of different sources.

- Facilitate communications between buyers, sellers and regulators of raw and intermediate materials.

IEC/TC113: Value Adding Chain for Nano-Electronics

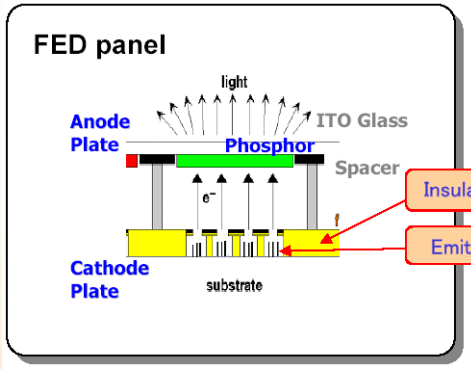


IEC/TC113: Value Adding Chain for Nano-Electronics



KCC: Key Control Characteristic

IEC/TC113: Value Adding Chain for Nano-Electronics



Nano Enabled Product

System Integration

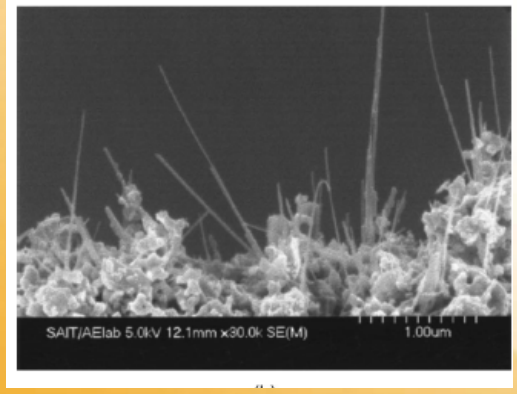
Nano Subassembly

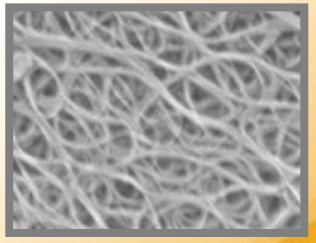
Subassembly #1

Subassembly #N

Nano Materials & Processes

Nano Science



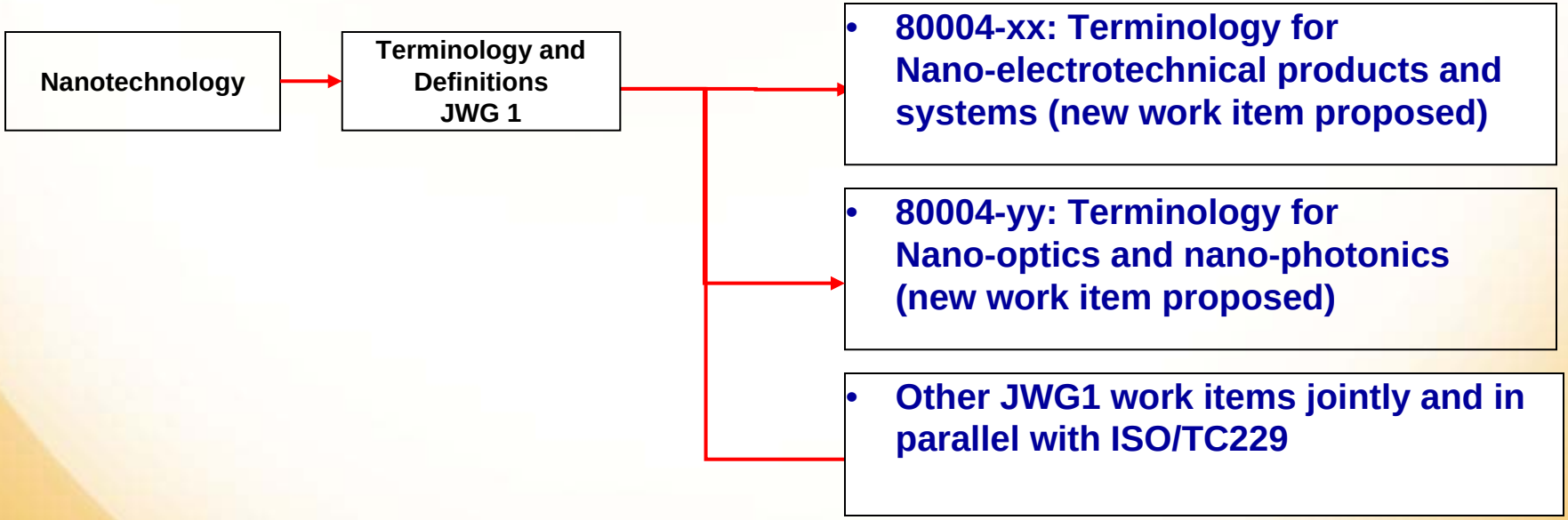


Key Control Characteristic:

An electrical property describing the CNT raw material for this application

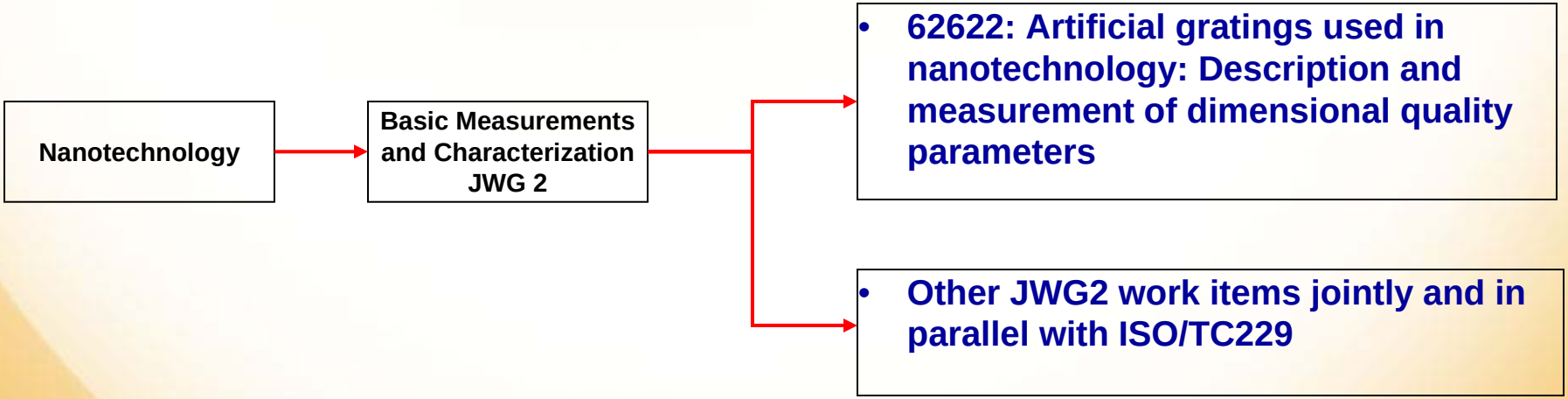
Prof. Young Hee Lee, Sungkyunkwan University, KO
Samsung

Nanotechnology Standards in IEC/TC 113 – JWG1



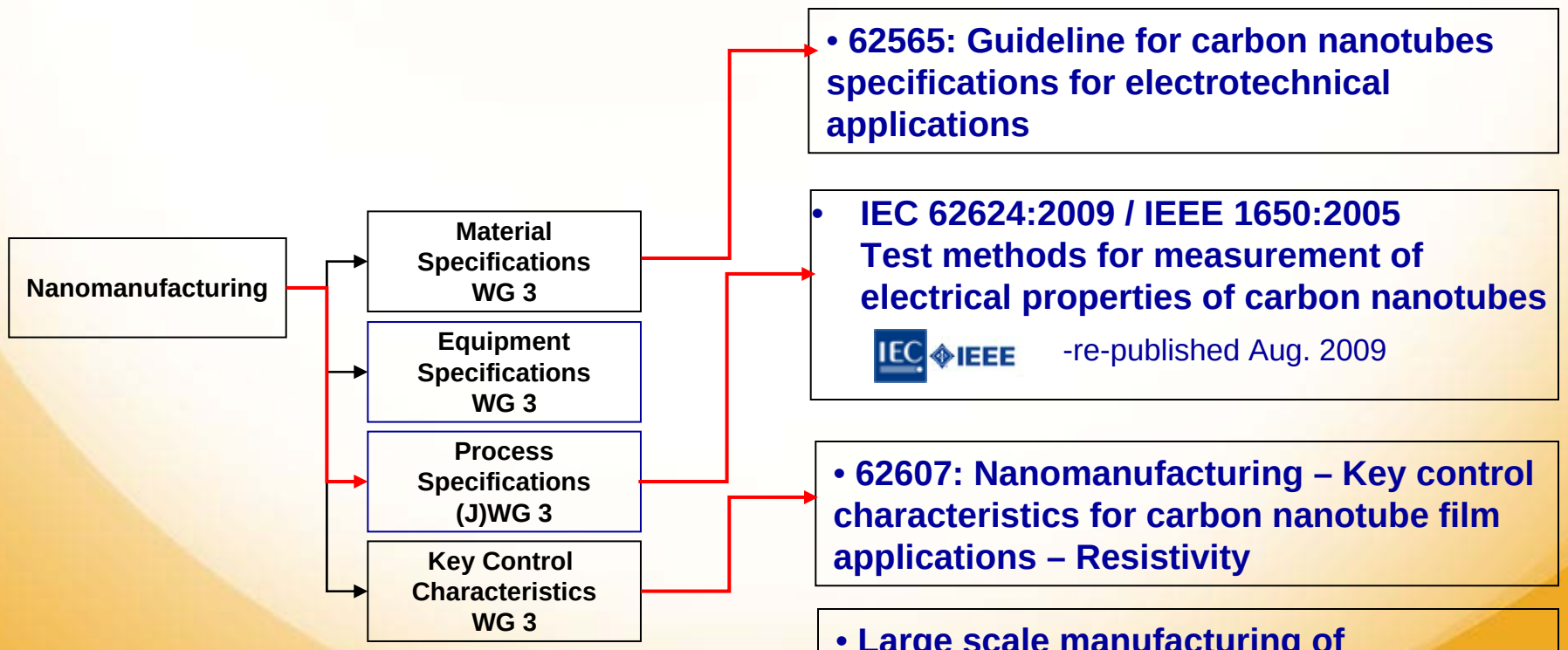
JWG1- Terminology and Definitions

Nanotechnology Standards in IEC/TC 113 – JWG2



JWG2 - Measurement and Characterization

Nanotechnology Standards in IEC/TC 113 - WG3



WG3 - Performance Assessment

Nanotechnology Standards in IEC/TC 113 – Future WGs

Reliability and FMEA WG 4

Nano-subassemblies and devices WG 5

Product Design WG 6

Become involved in ISO or IEC international nano-standards

CANADIAN STANDARDS ASSOCIATION

STANDARDS FOR CANADA - NANOTECHNOLOGIES

Canadian Advisory Committee (CAC) ISO/TC229, Nanotechnologies

Canadian SubCommittee (CSC) IEC/TC113, Nanotechnology standardization for electrical and electronic products and systems

Information for potential committee members:

Canada is actively participating in international standards development for nanotechnologies. Research scientists, physicists, chemists, engineers, manufacturers, regulators, and an evolving base of users, from Canada and over 28 other countries, are developing science-based standards to build world markets for nanomaterials, nano-based components and products. Nanotechnologies will find application in medical, construction, transportation, communications, electronics, energy, material science, and many other areas.

We invite new members for Canada's ISO/TC229 and IEC/TC113 national nanotechnologies committees. Be part of this important work, along with over 60 current members that represent a wide range of nano-sectors, interests, and geographical areas.

International standards are the basis for repeatable, accurate exchange of information among trading nations, providing a means to characterize and establish requirements for products, processes, and systems. For nanotechnologies, a challenge exists, to ensure the maximum potential of this technology is harnessed, while making certain that social, ethical and safety issues are properly addressed. Standards, developed by volunteer-member committees, can serve as a foundation for regulations. As well, it is recognized that a competitive advantage will go to industries demonstrating compliance with consensus-based standards.

At the international level, in 2005, Canada secured the convenorship for one of three working groups of ISO/TC229, specifically **WG1, Terminology and Nomenclature**. This is a highly visible role for Canada, in complement with **WG2, Measurement and Characterization** (convened by Japan), and **WG3, Health, Safety and the Environment** (convened by the United States).

Canadian Standards Association, accredited by Standards Council Canada, is the primary facilitator for Canada's nanotechnologies committees, which provide a cohesive, country-wide national forum for discussion, input, and participation in international standardization work. Standards developed internationally may be adopted/adapted for use as National Standards of Canada.

Canada's committee members review international drafts and documents on an Internet-based online workspace. Comments from members are received and compiled into single national positions for Canada, and are sent electronically to ISO or IEC's central office. Then review of input from all member countries occurs. The majority of Canada's members participate online and attend in-Canada meetings, held typically twice a year, in person or by teleconference, preceding international meetings. Some members choose to voluntarily serve as technical experts, participating directly in writing standards at international meetings. Proactive involvement by such experts and members, during development of standards, can ensure that Canada's stakeholder needs are met now, and for the future.

If you are interested in becoming a CAC ISO/TC229 or CSC IEC/TC113 member, please provide your contact information to Brian Haydon, P. Eng., Canadian Standards Association at brian.haydon@csa.ca, or call 416-747-4006 for further information. Thank you.

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- **In Canada:**
  - Has a national committee that mirrors the structure of the international committee
  - Provides comments and experts for ISO and IEC work
- **Other ISO/IEC member countries:**
  - Contact your National Standards Body for further information

ISO and IEC Standards for Nanotechnologies

Thank you

Questions?