

**NRC-CNRC**

*Institute  
for National  
Measurement  
Standards*

# ***ISO/TC229 – Documentary Standards for Nanotechnology***

**Jennifer E. Decker**

National Institute for Standards & Technology (NIST)

Gaithersburg, MD

6 February 2008



National Research  
Council Canada

Conseil national  
de recherches Canada

**Canada**

# Introduction

- Standards development in ISO/TC229: Nanotechnologies
  - Strategies
  - Activities
  - Potential topic areas for liaison

# Nanotechnology

- Study
- Development
- Processing
- Devices
- <100 nm *essential* to obtain the required functional performance

Norio Taniguchi, Tokyo Science University

- First to use the term in 1974, *College International pour la Recherche en Productique* (CIRP)

"*Nano-technology* mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule."

# Scope of ISO/TC229

Standardization in the field of nanotechnologies, with specific tasks being classification, **terminology and nomenclature**, basic **metrology, characterization**, including calibration and certification, risk and environmental issues.

The methods of test are to include methods for determining physical, chemical, structural and biological **properties of materials** or devices for which the performance, in the chosen application, is **critically dependent on one or more dimension of <100 nm**. Test methods for applications, and product standards shall come within the scope of the Technical Committee.

# ISO Technical Committee 229 IEC Technical Committee 113

- Joint Working Group 1: **terminology and nomenclature**
- Joint Working Group 2: **measurement and characterization**
- Working Group 3: **health, safety and environment**
- IEC TC/113 Working Group 3: **product specifications**



# Core Terms

- Core terms will consist of
  - base terms that run through the nanotechnologies subject domain (e.g., “nanoscale”, “nanoscale feature”)
  - names of the **broad categories** (or facets) of nanotechnologies
  - **hierarchically**, the terms directly beneath the broad categories, perhaps two layers deep
- Identification of core terms is important to the development of a terminology framework as the terms will provide the top levels of
- **taxonomic terminology**
  - Other JWG1 project groups will work on **deeper levels of the terminology** and provide definitions of terms

# JWG1 Review of term usage within TC229 and TC113

- A WG1 Task Force formed to review term usage, as a pilot project, to provide this service to the other WGs, when terms need clarification of correct usage in their draft documents.
- It has been recommended that a formal liaison and means be set up between JWG1 and JWG2, and JWG1 and WG3, to allow the review of terminology in all WG drafts.



**NRC-CNRC**

Institute  
for National  
Measurement  
Standards

# TECHNICAL SPECIFICATION

# ISO/TS 27687

First edition  
2007-##-##

---

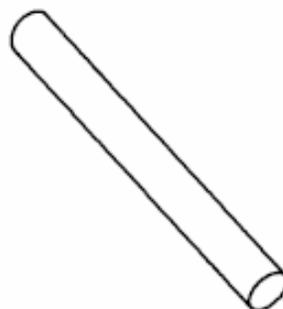
## **Nanotechnologies — Terminology and definitions for nanoparticles**

*Nanotechnologies — Terminologie et définitions relatives  
aux nanoparticules*

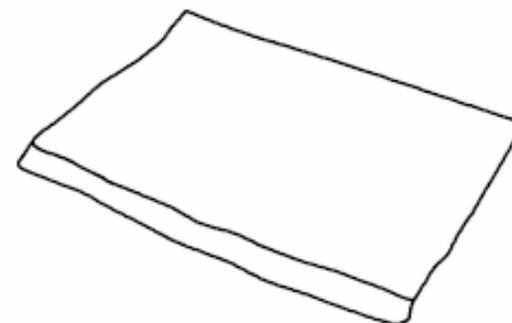
This document is concerned with the definition of terminology and definitions for these small objects. These objects come in several different shapes as illustrated in Figure 1:



a) particle



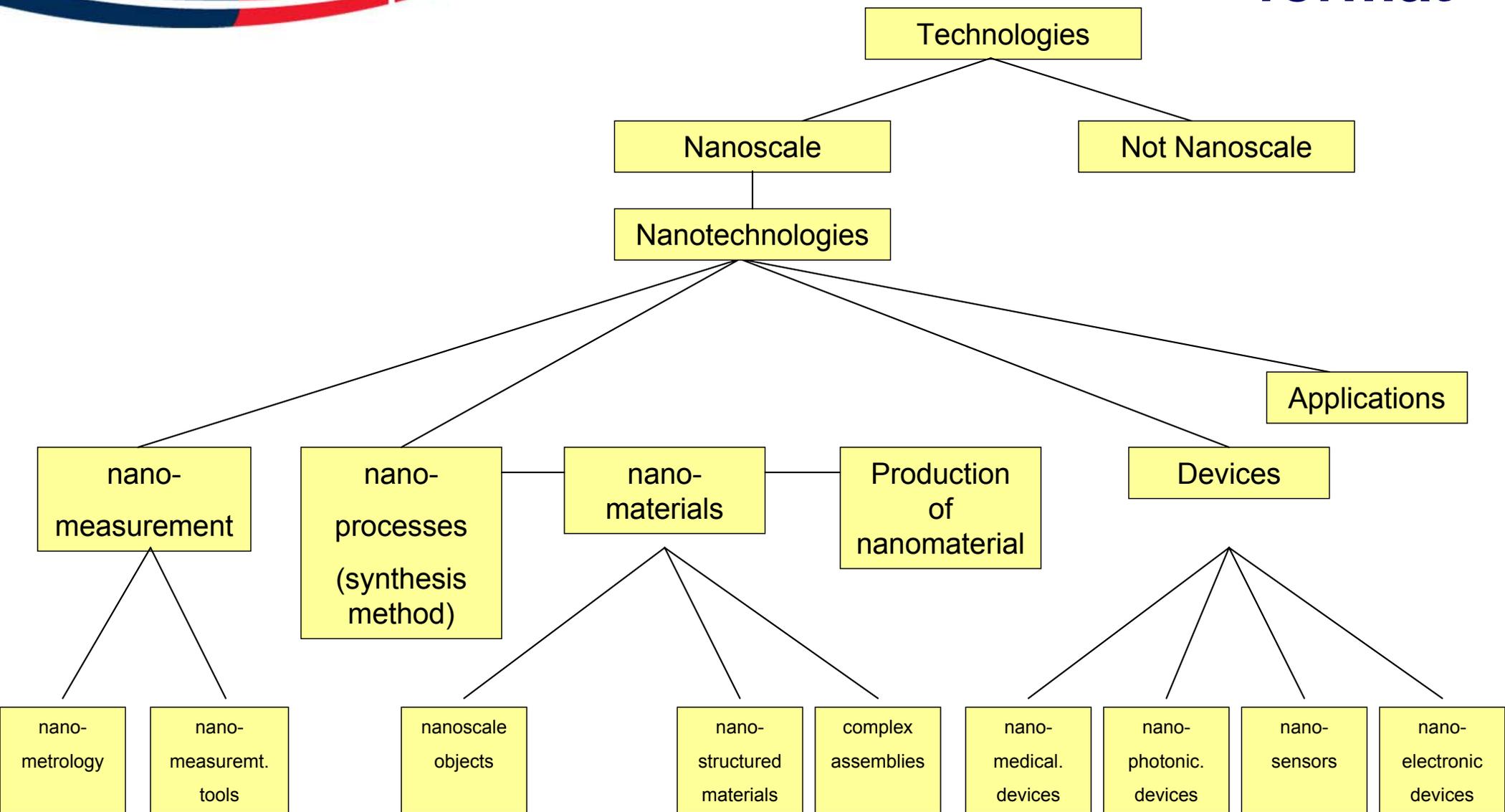
b) rod



c) plate

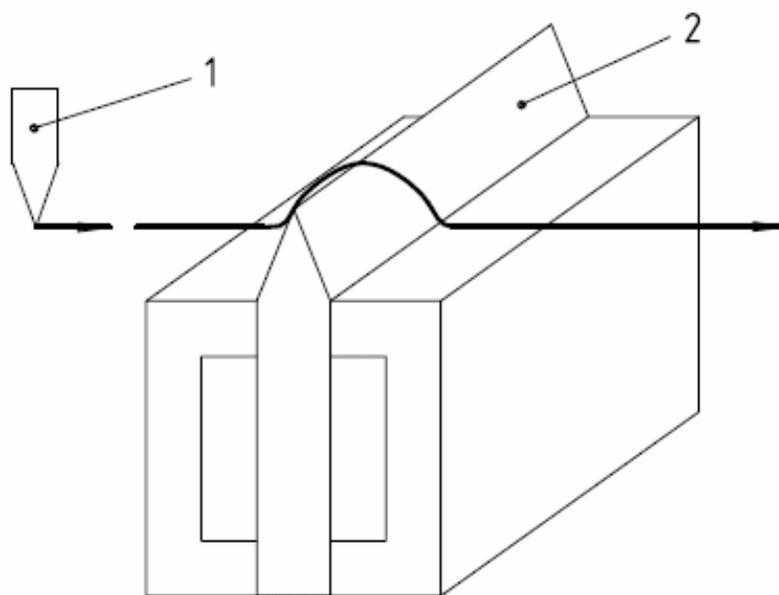
Figure 1 — Schematic diagrams showing some shapes for nano sized objects

# Strategic hierarchical format

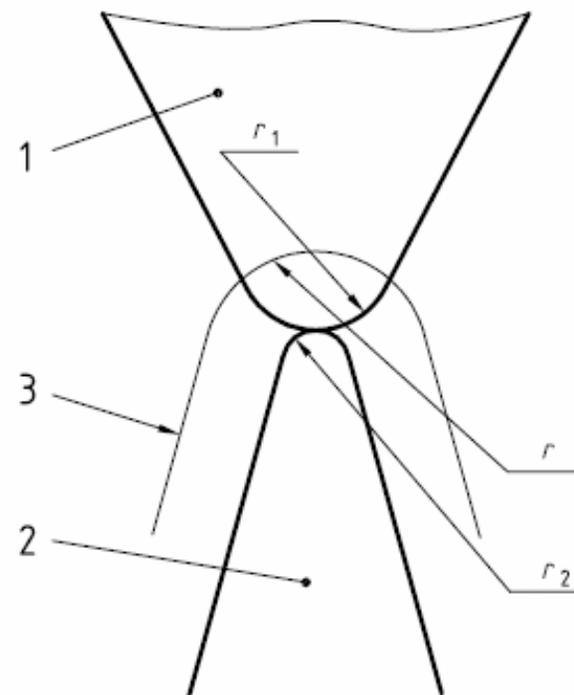


# ISO 5436:1(2000)E

## Surface Texture



Schematic diagram of razor blade trace for profiling the shape of a stylus tip to determine its radius



The output profile essentially represents the stylus tip shape if the radius and apex angle of the razor blade are much finer

### Key

- 1 Stylus
- 2 Razor blade
- 3 Recorded profile

# ISO/TC229 WG3 Top Needs Identified by ISO/TC229 Survey

**Standard Methods for Toxicological Screening of Nanomaterials**

**Standard Methods for Determining Relative Toxicity/Hazard Potential of Nanomaterials**

**Standard Guide for Controlling Occupational Exposures to Nanomaterials**

# Measurements: Backbone of R&D and Production

- Research: **comparative** measurements often sufficient
- Development: measurements must be **quantitative**
- Production: Quality System (ISO 17025)
  - correctness of the measurements formalized as a matter of importance for **compatibility and interchangeability**
  - **traceable** measurements are indispensable

# ISO/TC229 IEC/TC113 JWG2 Technical Specs Under Review SWCNT

- TS10797 Transmission Electron Microscopy (TEM)
- TS10798 Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Analysis (EDXA)
- TS10868 UV-Vis-NIR Absorption Spectroscopy
- TS10867 NIR-Photoluminescence (NIR-PL) Spectroscopy
- TS11251 Evolved Gas Analysis-Gas Chromatograph Mass Spectrometry (EGA-GCMS)
- TS11308 Thermo Gravimetric Analysis (TGA)
- TS10812 Raman Spectroscopy

# ISO/TC229 IEC/TC113 JWG2 Technical Specs Under Review MWCNT

- TS10929 Measurement Methods for the Characterization of MWCNTs
- TS11888 Mesoscopic Shape Factors

Task group to consider **harmonization of measurement protocols** and core terms for the projects being developed in JWG2, starting with **sample preparation**, followed by key term definitions (USA lead; to be presented to JWG1 for consideration)

# IEC/TC113 WG3

## Performance Assessment Work Items & Goals

- **Guideline for CNT for Electrotechnical Applications** to be developed within IEC/TC113 WG3 with consultation from ISO/TC229 JWG2
- **Interfacing** nanoscale devices with micro- and macro-scopic worlds
- **Terminology** for:
  - description of dimensional quality of nanostructured graduations
  - nano-optics
  - extension of electrotechnical vocabulary for nano



**NRC-CMRC**

*Institute  
for National  
Measurement  
Standards*

# ISO/TC229 IEC/TC113 JWG2 Study Groups

- Strategy
- Metrology

# ISO/TC229 IEC/TC113 JWG2 Metrology Priority Themes

- Best measurement practice:
  - Traceability to the SI
  - Models & evaluation of measurement uncertainty
  - Calibration artefacts
  - International Comparisons
  - Strong links within the international metrology community

# TS10797 Use of Transmission Electron Microscopy (TEM) Characterization of SWCNTs

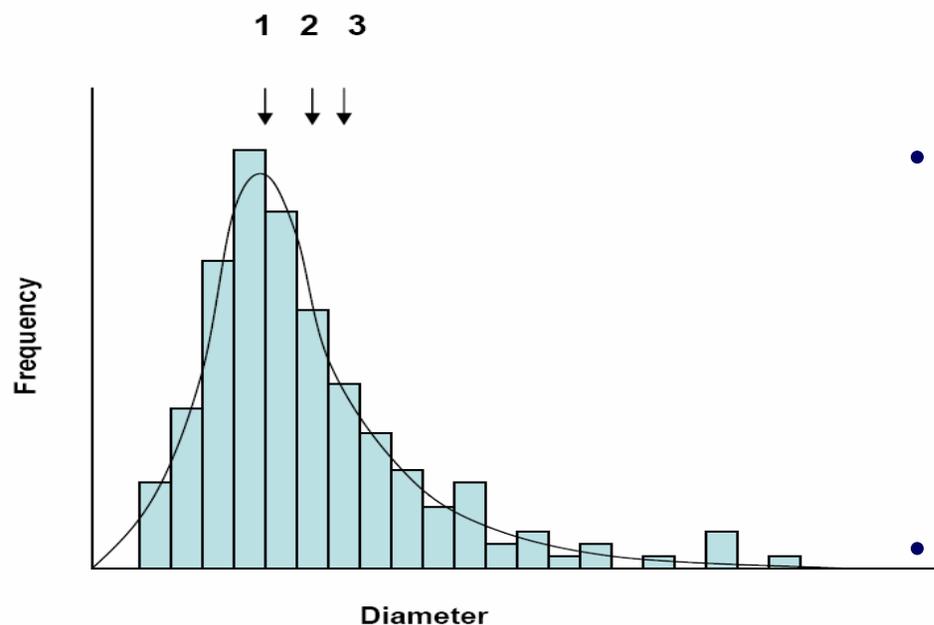


Figure 5 Typical nanotube diameter distribution with mode (1), median (2) and mean (3).

- High-resolution microscopy images determine position of atoms within materials;
- Qualitative purity assessment, morphology, structural features: graphene wall structure, defect, diameter, length, bundle size and orientation, tube-filling phenomenon;
- Suite of imaging modes and spectroscopic techniques possible: EDS, SAED (selected area diffraction), EELS, Bright & Dark field imaging

# ISO/TC229 IEC/TC113 JWG2 Strategic Priority Themes

1. carbon nanotubes and related structures
2. engineered nanoparticles
3. coatings
4. nanostructured materials (composites, porous structures)
5. standards for basic metrology at the nanoscale (basic length & force metrology)
6. standards for measurement, characterisation and use of reference nanomaterials and test nanostructures

# Priority Materials OECD

- Fullerenes (C60)
- SWCNTs
- MWCNTs
- Silver nanoparticles
- Iron nanoparticles
- Carbon black
- Titanium dioxide
- Aluminium oxide
- Cerium oxide
- Zinc oxide
- Silicon dioxide
- Polystyrene
- Dendrimers
- Nanoclays

# Strategic Measurement Characteristics OECD

- Length
- Purity
- Shape
- Specific surface area
- Surface charge
- Surface chemistry
- Water solubility/dispersability
- Zeta potential

# Priority Measurement Techniques Nanostrand - Europe

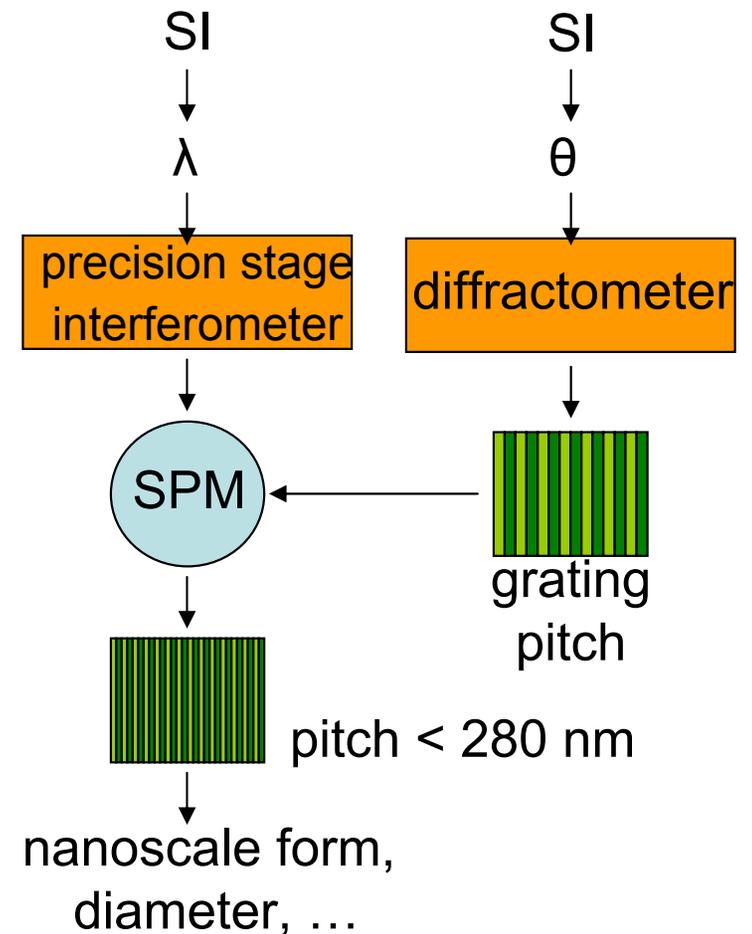
- Particle Size
  - Particle size
  - Size distribution
  - In air
  - In liquid
- Surface Characteristics
  - Roughness
  - Texture
  - Thin film
    - Thickness
    - Mechanical properties

# Priority Measurement Techniques Nanostrand - Europe

- **Microscopy**
  - AFM
  - Electron microscopy (TEM, SEM)
  - Ellipsometry
  - Scatterometry
  - Interferometric techniques
- **Physical & mechanical properties**
  - Strain
  - Hardness
  - Density
  - Force
  - Reference materials

# 'Gateway' Projects for nanoMetrology

- Grating pitch calibration by diffraction
- Atomic Force Microscope (AFM)
  - Components commercially available



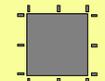
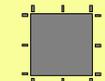
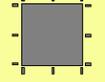
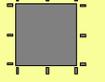
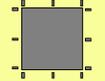
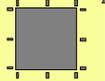
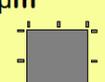
# 'Gateway' Projects for nanoMetrology

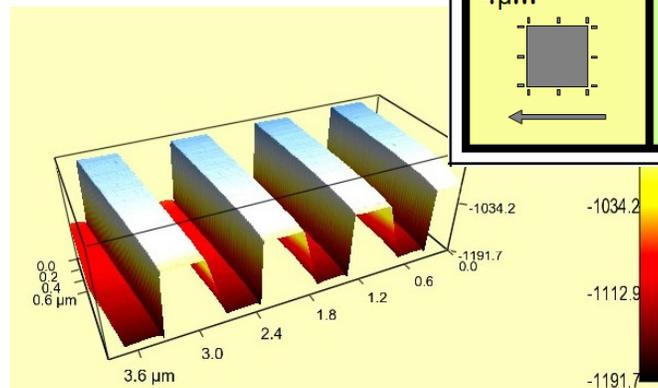
- Reference materials/artefacts
  - Grating pitch artefacts
  - SWCNT reference materials



# Suggestions for Cooperation between TCs

- Interpretation of AFM in the context of CMM
  - Refer to ISO/TC213 CMM standards work
- Artefact Standards
  - Pitch artefacts and/or linescales
  - Linewidth
  - Step height

1µm 	<b>NRC 1D Grating Pitch Standard</b> Model: NRC-1D-GPS-1		2µm 
National Research Council Ottawa, Canada Canadian Photonic Fabrication Centre www.cpfcc.ca	150nm 	200nm 	Institute for National Measurement Standards www.inms.nrc.gc.ca © <b>NRC-CNRC</b> 2006
	350nm 	700nm 	
4µm 	<b>S/N: 1GK</b>		10µm 



# Summary

- Identification of priorities – materials and their characterization
  - Terminology & Nomenclature
  - Measurement & characterization
  - Health, Safety & Environment
- Opportunity for:
  - Directed and blue-sky R&D
  - Liaison, collaboration, complementary work
    - Standards development in ISO/TC229: Nanotechnologies
    - Stakeholders meeting hosted at NIST 26 Feb 08

**NRC CNRC**

*Institute  
for National  
Measurement  
Standards*

Science  
— at work for —  
Canada



National Research  
Council Canada

Conseil national  
de recherches Canada

Canada