A common European approach to the regulatory testing of nanomaterials

Metrology and Standardization as nanotechnology legislation support

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IPQ, Caparica 3 April 2014
Summary

• Metrology
• Nanometrology
• Conformity assessment
• Players in the field
  • Metrology institutes
  • Standardizations body
  • Research centers
  • Regulatory bodies
• Conclusions
Metrology

Science of measurement and its application.

includes all theoretical and practical aspects of measurement, whatever the measurement uncertainty and field of application.

International Vocabulary of Metrology -- Basic and general concepts and associated terms (VIM), Available from www.bipm.org

“If you can’t measure it, you can’t improve it”

Lord Kelvin

1st NATIONAL MEETING “Nanotechnology: Regulate to compete”, IPQ, Caparica 3 April 2014
Measure for what?

- **Supervise / Monitor**
  (observe and record - Commercial transactions: buying and selling products, water, fuels light)

- **Check / Control**
  (compare and act to keep within specified values)

- **Investigate, innovate, create**
  (understand the small differences, compare results)
Measurement

Process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity. Measurement implies comparison of quantities or counting of entities (VIM 2.1)

Measurement standards
Hierarchy of measurement standards

- **SI**
  - BIPM
  - international measurement standard

- **NMI**
  - national measurement standard

- **Accredited laboratories**
  - secondary measurement standard

- **Industry**
  - working measurement standard
Nanometrology

Science of measurements at the nanoscale
(1 nano[unit] = a 100 nano[unit] (=10^{-9} [unit]))

Is not a special kind of metrology
Concepts such metrological traceability, uncertainty method validation are the same.

New challenges
(new reference materials, measurement instrumentation, test methods, environments: vacuum or biological media)
National Metrological Institutes

New method for the measurement of structure widths with atomic resolution

Calibrating accurately and traceably using a combination of a transmission electron microscope and an atomic force microscope

Aromatic graphene

New production method broadens the perspectives for the utilization of the “magical material” – many different forms are possible


The cover picture of the scientific journal “Advanced Materials” gives a schematic representation of the conversion of the monolayer of the complex molecule biphenyl thiol into the two-dimensional graphene crystal by electron irradiation and thermal treatment. (Fig.: Advanced Materials 25 (2013). Copyright Wiley-VCH Verlag G mbH & Co. KGaA. Reproduced with permission.)
Characterization
(measurement of physical and chemical properties: size, force, shape, composition)

Mechanics
(measurement of mechanical properties: hardness, elasticity, nanotribiology, volume materials)

Photonics, Electronics, Magnetics
(reproducible measurements of: resistance, refractive index)

Fabrication – manufacturing
metrology to support the manipulation of matter on an atom scale, measurement methods to control and predict the nanoscale structure
Nanometrological challenges

- New reference materials
- Long chains of metrology traceability
- New measurement instrumentation
- Measurement of new characteristics unique to the nanoscale
- Rapid and accurate calibration methods against a known standard
- Measurement in exigent environments
Importance of Metrology

- Improvement of the scientific understanding
- Quality control and conformity assessment
- Elimination of trade barriers
- Confidence for the consumer
Conformity assessment

1. Initial specifications of the product requirements of the customer
2. Match measurement specifications to product specifications
3. Selection of measurement method and equipment with metrological performance appropriate
4. Measurement and report
5. Use of the measurement results by customer for product conformity

| Conform | Not conform |
Players in the field

- Metrology Institutes (NMI)
- Standardization bodies
- Research centres
  - University, Laboratory
- Industry
- Citizens
Metrology Institutes (NMI)

- Development and realisation of measurements at the highest level of accuracy and with the smallest uncertainty
- Demonstration of compatibility results by international comparisons make sure that measurement results agree within their uncertainties.
- Production of certified reference materials
- Comparability of SI-traceable measurement results performed with high accuracy measurement instrumentation
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Instituto Português da Qualidade
Standartization Bodies

- CEN – European Committee for Standardization
- ISO – International Organization for Standardization
- CENELEC – European Committee for Electrotechnical Standardization
- ETSI – European Telecommunications Standards Institute
- IEC – International Electrotechnical Commission
The IPQ is the National Standardization Body

Assignments to NSB/IPQ:

• Overall coordination of national standardization;
• Voting process;
• Approval and edition of Standards;
• Adoption of European Standards;
• Representation of the NSB/IPQ at the highest levels of the
• CEN/CENELEC and ISO/IEC.
The national structure of Standardization

IPQ

National Standardization Body

ONS

ONS - Sectorial Standardization Body

OGCT

OGCT - Technical Committee Management Body

CT

CT - Technical Committee for Standardization
Standardization

Technical standards

- Written voluntary document laid down by a specialized body on the basis of a consensus between experts appointed by the stakeholders.

- It may set out specifications for a specific physical object, terminology, process and organizations, good laboratory practice, social responsibility ...
Standardization

CEN/TC 352 - Nanotechnologies

- understanding and control of matter and processes at the nanoscale, typically, but not exclusively below 100 nanometres in one or more dimensions, where the onset of size dependent phenomena usually enables novel applications,

- utilizing the properties of nanoscale materials that differ from the properties of individual atoms, molecules or bulk matter, to create improved materials, devices and systems that exploit these new properties

Specific tasks include developing standards for: classification, terminology and nomenclature; metrology and instrumentation, including specifications for reference materials; test methodologies; modelling and simulation; science-based health, safety and environmental practices; and nanotechnology products and processes. Standards in each of these areas could be specific to a product, process or industry.
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ISO/TC 229 - Nanotechnologies

P. Hatto; Needs and Expectations from the ISO TC 229 Nanotechnologies; BIPM Workshop on Metrology at Nanoscale, Paris, 18-19 February 2010
## CEN/TC 352 - Nanotechnologies

<table>
<thead>
<tr>
<th>Subcommittees and Working Groups</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEN/TC 352/WG 1</td>
<td>Measurement, characterization and performance evaluation</td>
</tr>
<tr>
<td>CEN/TC 352/WG 2</td>
<td>Commercial and other stakeholder aspects</td>
</tr>
<tr>
<td>CEN/TC 352/WG 3</td>
<td>Health, safety and environmental aspects</td>
</tr>
</tbody>
</table>

http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=381983
Acedido em 2014-03-28
Ambitions for Nanotechnologies Standardization

- Definition of agreed terminology for nanotechnologies
- Definition of protocols for toxicity testing of nanoparticles
- Definition of protocols for evaluating environmental impact of nanoparticles
- Definition of protocols for whole life cycle assessment of nanoscale materials and products
- Developing occupational health protocols in particular for industries dealing with nanoparticles and nanoscale devices
- Developing test methods to detect, characterize and identify nanoparticles
CEN/TC 352 - Nanotechnologies


http://standards.cen.eu
Metrology and Standardization

- Support regulation in the area of nanotechnologies
- Support of safety testing
- Support of worker, public and environmental safety
Legal metrological control

ISO 6142:2001 - Gas analysis - Preparation of calibration gas mixtures - Gravimetric method

OIML R 99-1: Instruments for measuring vehicle exhaust emissions.

ISO 1155:1978 - Information processing - Use of longitudinal parity to detect errors in information messages

OIML R 91: Radar equipment for the measurement of the speed of vehicles

Portaria 20/2007 de 5 de janeiro

Portaria 1542/2007 de 6 de dezembro
Conclusion

Metrology + University + Industry + 
Investigations centres + Trade Union + 
Industrial Associations + Regulators

• ONS – LNEG: Laboratório Nacional de Energia e Geologia

- Standardization Portuguese: technical commitee for Nanotechnologies
Thank you

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