Nanometrology, nano-eco-toxicology and standardization

Emilio Prieto
Centro Español de Metrología (CEM), C/Alfar 2, Tres Cantos (Madrid), Spain
Chairman of the AENOR GET 15 Committee on Standardization on Nanotechnologies, AENOR, Génova, 6, 28004 Madrid
eprieto@cem.mityc.es

Nanotechnologies enable scientists to manipulate matter at the nanoscale (size range from approximately 1 nm to 100 nm) [1]. Within this size region, materials can exhibit new and unusual properties, such as altered chemical reactivity, or changed electronic, optical or magnetic behaviour. Such materials have applications across a breadth of sectors, ranging from healthcare to construction and electronics.

Quantitative determination of properties of micro and nanostructures is essential in R&D and a pre-requisite for quality assurance and control of industrial processes. The determination of critical dimensions of nanostructures is important because the linking to many other physical and chemical properties depending on such dimensions. To get quantitative measurements is essential to count with accurate and traced measuring instruments, together with validated measurement procedures widely accepted [2].

Geometric features decisive for nanotechnology applications include 3D objects like large molecules (e.g. DNA), clusters of atoms (e. g. bucky balls), nanoparticles (like TiO_2 particles added to products to improve reflectivity), nanowires (like carbon nanotubes (CNT), single-walled CNT (SWCNT), multi-walled CNT (MWCNT)), surfaces structures (super-hydrophobic surfaces, riblets) and thin films covering large surfaces (hardness, scratch-resistance, reflectivity, wetting properties …) [3].

So, nanometrology, the science of measurement applied to the nanoscale plays a key role in the production of nanomaterials and nanometre devices. But most of the today's efforts in Research are not successful and they won't be if there is no transfer to industrial applications. In fact, nanotechnology has not yet emerged as massive production due to both the difficulty of developing a solid nanometrology infrastructure and the lack of awareness about it by researchers, product developers and R&D funders.

Instruments and techniques used today at the nanoscale are many and varied: exploration probes, ion beams, electronic beams, optical means, X-ray, electromagnetic means, mechanical techniques, etc. New instruments offer every day better capabilities but such equipments should be correctly calibrated in order to maintain their metrological capabilities (traceability, accuracy) so guarantying the reliability of the results, something crucial in R&D and industrial production.

Creation of metrological infrastructure and means has been intended for years by National Metrology Institutes (NMIs) by using specific tools, as the European Metrology Research Programme (EMRP)(www.emrponline.eu), the NanoScale series of Conferences (http://www.nanoscale.de/) where, since 1995, the main developments on quantitative measurements at the nanoscale have taken place, the Coordination of Nanometrology Initiative (www.co-nanomet.eu), funded under the European Commission FP 7 and others.

But apart of potential benefits to consumers, nanotechnologies may also present new risks it is necessary to study, as a result of their novel properties. A report by the European Union Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published in 2009, listed a number of physical and chemical properties which affect the risk associated with nanomaterials [4], among them size, shape, solubility and persistence, chemical and catalytic reactivity, anti-microbial effects or aggregation and agglomeration. This is particularly important in the Food Sector. The European Union has provided €40 million in funding for nanomaterials safety research in the last three years, along with another €10 million in 2009. Studies on nano-eco-toxicology, together with standardization issues, are then important and urgent matters today at international level.

A forum where international coordination is taking place is the OECD which, at the present time, plays a central role in the coordination of research efforts for the development of test methodologies for risk assessment which will underpin the regulation of nanotechnologies. Some of the OECD Committees and Working Groups related to nanotechnology are: the Working Party on Chemicals, Pesticides and Biotechnology, the Working Party on Manufactured Nanomaterials, and the Working Party on Nanotechnology.

REACH—European Community legislation concerned with chemicals and their safe use—plays also a role, albeit limited, in regulating nanomaterials. The general opinion today is that REACH can adequately regulate nanomaterials, but there is a need for future revisions of REACH to move the focus of regulation from the size/shape of nanomaterials to also their functionality [5].

Finally, there is also a key role for standardization related to measurement and characterization, and testing of the characteristics and behaviour of nanomaterials and the exposure assessment, complementing the work being carried out in the framework of the OECD and in the context of the implementation of REACH. The European Commission therefore requests CEN, CENELEC and ETSI to develop standardization deliverables applicable to a) Characterization and exposure assessment of nanomaterials and b) Health, Safety & Environment.

Spain is participating actively in the works of ISO/TC 229, CEN/TC 352 and IEC/TC 113 Committees through the AENOR GET 15 Committee on Nanotechnologies. Matter under study is divided into four main fields: 1) Terminology and Nomenclature, 2) Measurement and Characterization, 3) Health, Safety and Environment and 4) Material Specifications. About 40 technical specifications and international standards are today under production for the ulterior benefit of all stakeholders (R&D, industries, citizens, …). Some of them are already appearing in Spanish as UNE-CEN ISO Standards.

On this talk a general view of all these activities and aspects of nanotechnologies is presented, highlighting the importance of all of them for the industrial development of nanotechnologies and the protection (health and safety) of citizens and the environment.

References:

[1] ISO TS 27687:2008, *Nanotechnologies – Terminology and definitions for nano-objects – Nanoparticle, nanofibre and nanoplate*, 1st ed., 15-08-2008.
[2] *Nanoscale Metrology*, Editorial, Meas. Sci. Technol. 18 (2007).
[3] Scanning Probe Microscopy, Scanning Electron Microscopy and Critical Dimension: Nanometrology: Status and Future Needs within Europe, European Nanometrology Discussion Papers, Co-Nanomet, November 2009.
[4] SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), *Risk assessment of products of nanotechnologies*, 19 January 2009, pp 15-16.
[5] Royal Commission on Environmental Pollution (RCEP), UK, Novel Materials in the Environment: The case of nanotechnology, p 64, Nov. 2008.