NANOTECHNOLOGY TECHNICAL STANDARTIZATION REVIEW

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Abstract

Technical standardization of nanotechnology is a great challenge because of specific almost unknown properties of nano-sized materials and still developing methods and instruments for nanomaterial production and testing. The necessity of preparing nanotechnology standards is evident and numbers of international standards were issued during last few years. This paper presents a current status of standardization of nanotechnology at international and national level and gives a review of actual standardization topics to be solved.

KeyWords: Technical standardization, nano objects, ISO, CEN

1. INTRODUCTION

Nanotechnology is a relatively new term [1] used for wide field of interdisciplinary science. Term nanotechnology is used not only at scientific level, but it is still more often used for commercial purposes to promote still expanding number of products. Today's market offers few thousands of commercial available nanotech based products, which improves product properties compared to products using standard technology. Some nano-products don’t emphasize it's nano-based primer, because majority of customers and users don’t have right idea what nanotechnology really means and what advantages and risks can cause.

Universally accepted definition says that nanotechnology can be described as all such materials, systems, applications or forms of structures and materials that meet the following conditions:

1. They have at least one dimension or their internal structure within the size range 1 to 100 nm (0.001 to 0.1 μm)
2. They use physical or chemical properties at the level of atoms and molecules, so they have unusual characteristics compared with the same material or system that has not components within nanosize range
3. They must be prepared artificially, and can be combined to form larger structures with usable effects in macrocosm

Such general definition of nanotechnology includes a huge variety of materials, structures, processes, and their use in many different fields of human activity that are not only used in the last 20 years, when talking about nanotechnology. The people either consciously or unconsciously uses nanotechnology since the beginning AD. In addition, many natural nanomaterials arises entirely natural processes and ultimately living organisms themselves make use of nanotechnology-based processes for their own living.

The mentioned issue of nanotechnology is very broad and transcending existing boundaries of science and technology and is therefore of interest to many groups of society from scientists and engineers, through the soldiers, businessmen, economists, policy to customers and other groups. The first commercial products used nanotechnology based principle became available since 1997 (GMR Read Head of hard drives). Since that steadily growing market of nano-based products is still expanding, and became so interesting in economic and political fields.
2. NANOTECHNOLOGY STANDARDIZATION

2.1 Beginning of nanotechnology standardization

A growing economic and know-how related nanotechnology market growth of job opportunities, but arises also issues of safety, health risks and other aspects. Risk of safety and health aspects are usually reduced by application of standardization process in all fields of human activity, and therefore all areas related to the field of nanotechnology has become the subject of standardization. This process is enforced by effort to ensure smooth and responsible development of the nanotechnology market and in particular to ensure opportunities for safe risk management of these new technologies and to minimize negative viewing of nanotechnology known as in the case of GMO.

On this bases arise around the world at the instigation of government and other organizations standardization committees dealing with nanotechnology in the mid-tenth of the 21st century. The ANSI-Nanotechnology Standards Panel NSP arises in August 2004 and it finally formed the separate ISO technical committee ISO / TC 229 – Nanotechnologies in June 2005. Similarly, the European Commission initiated the establishment of working group WG166 within CEN (Comité Européen de Normalisation) in 2004, whose task was to standardize pan-European survey of needs in the field of nanotechnology. A new Technical Committee CEN/TC 352 - Nanotechnologies was established on the basis of this survey in 2006. The ISO called the other member states to establish its mirror national standardization committees of ISO / TC 229 – Nanotechnologies for the preparation and adoption of standards issued or adopted by individual Member States. The Czech Republic followed this call and established the mirror committee TNK CNI 144 - Nanotechnology and in 2007.

2.2 International standardization of nanotechnology

Working program of mentioned national and international standardization committees is broadly similar. Since nanotechnology is a completely new science and technology, it is necessary to build a complete standardization system from the ground, namely, to standardize terminology and nomenclature to describe and specify all things, then describe instrumentation and methods of testing and measurement of individual nanomaterials, including the definition of reference materials. Then main attention will be focused on the problems of modeling of nanomaterials, including safety issues of these materials and their potential impact on human health and the environment in general.

The greatest difficulty for nanotechnology standardization process is that the nanotechnology scope extends to many areas already covered by standardization. But for characterization the properties and in particular the impact of potential risks of nanomaterials is not possible use already established standardized procedures in general. Thus standardization documents preparation process is leaded by experts in working groups with close contacts to other technical committees, its working groups and other organizations through liaisons. An example of relevant and potential liaisons for ISO/TC 229 is shown in the Figure 1.
Fig. 1 Review of current and potential liaisons for ISO/TC 229 [2].

The relevant international source of standardization documents for The Czech Republic is the ISO / TC 229 - Nanotechnologies, which during its existence until today issued a total of 25 standards documents [2]:

**ISO/TS27687:2008** Nanotechnologies -- Terminology and definitions for nano-objects -- Nanoparticle, nanofibre and nanoplate

**ISO/TR 12885:2008** Nanotechnologies -- Health and safety practices in occupational settings relevant to nanotechnologies

**ISO 10801:2010** Nanotechnologies -- Generation of metal nanoparticles for inhalation toxicity testing using the evaporation/condensation method

**ISO 10808:2010** Nanotechnologies -- Characterization of nanoparticles in inhalation exposure chambers for inhalation toxicity testing

**ISO/TS 10867:2010** Nanotechnologies -- Characterization of single-wall carbon nanotubes using near infrared photoluminescence spectroscopy

**ISO/TS 11251:2010** Nanotechnologies -- Characterization of volatile components in single-wall carbon nanotube samples using evolved gas analysis/gas chromatograph-mass spectrometry

**ISO/TR 11360:2010** Nanotechnologies -- Methodology for the classification and categorization of nanomaterials

**ISO/TR 12802:2010** Nanotechnologies -- Model taxonomic framework for use in developing vocabularies -- Core concepts
ISO 29701:2010  Nanotechnologies -- Endotoxin test on nanomaterial samples for in vitro systems -- Limulus amebocyte lysate (LAL) test
ISO/TS 80004-1:2010  Nanotechnologies -- Vocabulary -- Part 1: Core terms
ISO/TS 10868:2011  Nanotechnologies -- Characterization of single-wall carbon nanotubes using ultraviolet-visible-near infrared (UV-Vis-NIR) absorption spectroscopy
ISO/TR 13121:2011  Nanotechnologies -- Nanomaterial risk evaluation
ISO/TR 10929:2012  Nanotechnologies -- Characterization of multiwall carbon nanotube (MWCNT) samples
ISO/TR 13014:2012  Nanotechnologies -- Guidance on physico-chemical characterization of engineered nanoscale materials for toxicologic assessment
ISO/TR 13014:2012/Cor 1:2012

Next 20 standardization documents are under development under ISO/TC 229 lead. These are not only ones standardization documents related to nanotechnology at international level. Standardization of electrical, electronic and related technologies is covered by International Electrotechnical Commission (IEC). Topics of nanotechnology are in scope of technical committee IEC-TC 113 Nanotechnology standardization for electrical and electronic products and systems. This committee issued 3 standards documents and next 15 are under development [4]:

IEC/TR 62607-2-1 Nanomanufacturing - Key control characteristics - Part 2-1: Carbon nanotube materials - Film resistance
IEC 62624 Test methods for measurement of electrical properties of carbon nanotubes

2.3 Nanotechnology standardization at European level

At European level the most important institution for standardization is CEN - Comité Européen de Normalisation where the process of nanotechnology standardization is provided by the Technical Committee CEN / TC 352 Nanotechnologies. This committee has been since its inception in 2006, as well as ISO / TC 229 headed by secretariat BSI - British Standards Institution and the chairman of both committees was dr. Peter Hatto. For the harmonization of international and European standards and to avoid duplications in standards preparation a close technical cooperation between ISO and CEN was enshrined in the Vienna
Agreement in 1990. CEN and ISO may previously agree which standardization project will be addressed under ISO or CEN leadership and after the development of standardization document it will be approved in both of these partner organizations. Until now member states of CEN / TC 352 Nanotechnologies have been approved and published four normative documents, namely [5]:


The main working program of CEN/TC 352 is focused on European Commission M/461 Standardization Mandate to CEN, CENELEC and ETSI for standardization activities regarding nanotechnologies and nanomaterials with close cooperation with ISO and OECD. This mandate concerns to development of standardization documents especially in areas:

- Methodologies for nanomaterial characterization in the manufactured form and before toxicity and eco-toxicity testing;
- Sampling and measurement of workplace, consumer and environment exposure
- Methods to simulate exposures to nanomaterials
- H, S & E (health, safety and the environment)

CEN/TC 352 have prepared nine standardization projects and called tenders for project leaders of five projects:

1) CEN Technical Specification (TS) “Guide to the identification and definition of measurands required for characterizing, evaluating functional properties and performance of materials at the nanoscale”
3) CEN Technical Specification (TS) “Guidance on detection and identification of nanoparticles and other nanoscale entities (in all media types, including waste streams from manufacturing and manufacturing discharges)”
4) CEN Technical Specification (TS) “Protocols for determining the explosivity and flammability of nanopowders (for transport, handling and storage)”
5) CEN Technical Specification (TS) “Guide to the management of waste and the disposal of nanomaterials”

The next projects tenders will be called as soon as at least three member countries will be interested in it.

2.4 The Czech national standardization body

The Czech National technical committee TNK 144 – Nanotechnologie was established as mirror committee of ISO 229 – Nanotechnology under Czech Metrology Institute (CMI) in 2007. The successor organization of CMI the Czech Office for Standards, Metrology and Testing (UNMZ) succeeded in tender for CEN/TC 352 - Nanotechnology secretary abandoned by BSI and become the first CEN twinning secretariat with AFNOR (France) since February 24 2011. Till today TNK 144 – Nanotechnologie issued 7 standard documents and other are under development:
3. CONCLUSION

This article aimed to provide an overview of the current state of technical standardization, newly established, very broad technical field such as nanotechnology. Thanks to intensive development and its widespread impacts in all fields of human activity is the standardization in this field one of the priorities of many governments around the world. Despite all the so far unknown factors associated with nanotechnologies are appropriate normative documents intensively and systematically prepared by experts from around the world. Czech Republic is actively engaged in nanotechnology standardization process at all standardization bodies ISO, CEN and IEC through UNMZ.

ACKNOWLEDGEMENT

This work was supported by grant: AV ČR IAA200760905.

LITERATURE