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To the Members of CEN/TC 352
Nanotechnologies

International Standards in Nanotechnology

- a report made available by Nanoposts.com, an information exchange website of the Technology Transfer Centre (IoN)

International Standards in Nanotechnology

Nanoposts.com

2007

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1 INTRODUCTION

Currently there are:

- No agreed terminology/definitions for nanotechnology(ies)
- No agreed protocols for toxicity testing of nanoparticles
- No standardized protocols for evaluating environmental impact of nanoparticles
- Existing ‘methods of test’ may not be suitable for nanoscale devices and dimensions
- Measurement techniques and instruments need to be developed and/or standardized
- Calibration procedures and certified reference materials (CRMs) needed for validation of test instruments at nanoscale

International Standards are needed to facilitate nanotechnology commercialization and social acceptance of nanotechnologies. The German standards authority DIN has reported that in Europe standardization adds approximately 1% to the value of gross domestic product and that the added value generated by standardization is at least as important as the value generated by patents. International Standards provide industries, societies and academia with common:

- Languages;
- Methods;
- Practices;
- Products.

Standards and specifications foster a common communication platform, enable faster commercialization and inter operability, rapid design, easier installation and testing, reduce costs and help to protect users and the environment. As progress accelerates in the manufacture and characterization of nanoscale materials and nano enabled products, it will become increasingly important to researchers, manufacturers, regulators, and other stake-holders to have agreed upon nanotechnology standards. Such standards will include nomenclature/terminology with which to communicate; testing and characterization methods to compare results; and materials properties to facilitate commercialization of the many and varied applications and uses of nano materials.

Despite the broad constituency involved in nanotechnology standards development, there is a fairly broad consensus on standardization needs and priorities. Standards in nanotechnology are needed to document processes, clarify terminology, facilitate uniform measurement and repeatable results and characterize materials. Nanotechnology has an international group of

stake-holders across a broad range of industry sectors. Nanotechnology-related standards must be internationally recognized and adopted; otherwise market access will be limited and commercialization will be slowed.

Because nanotechnology impacts many industry sectors, standards development should involve stakeholders from multiple industries around the world. This represents a key challenge for standards development organizations (SDOs).

This common call for a diverse array of standards from industry, academia and government has been documented and SDOs have moved to fill the gap. SDOs help insure the integrity of nanotechnology standards, maximize adoption of the technology, and gain public confidence in nano-based products. Collaboration between SDOs and the nanotechnology community is creating a powerful force to support the commercial promise of nanotechnology.

Current focus of standardization efforts in nanotechnology is centered in four broad areas:

- terminology and nomenclature (providing a common framework for communications about nanotechnology for commercial, scientific, and legal purposes);
- nano materials (characterizing physical and chemical properties of nano materials for various applications);
- safety and risk assessment (developing evaluation methods to prove suitability, toxicity, health and potential environment effects on human body);
- nanometrology (developing methods, equipment and systems to measure basic characteristics of nano products).

2 INTERNATIONAL

2.1 ASTM International

ASTM International is a voluntary standards development organization for technical standards for materials, products, systems, and services.

2.1.1 E56 Committee on Nanotechnology

Scope

- The development of standards and guidance for nanotechnology and nano materials;
- The coordination of existing ASTM standardization related to nanotechnology needs;
- The maintenance of appropriate global liaison relationships with activities related to nanotechnology;
- Participation in the development of symposia, workshops and other activities to enhance the development of standards.

E56 Subcommittees

- E56.01: Terminology & Nomenclature
- E56.02: Characterization
- E56.03: Environmental & Occupational Health & Safety
- E56.04: International Law & Intellectual Property
- E56.05: Liaison & International Cooperation
- E56.06: Risk Management and Product Stewardship
- E56.90: Executive
- E56.91: Strategic Planning and Review

Work Items (standards in development)

- WK8051: Standard Terminology for Nanotechnology
- WK8985: Standard Guide for Handling Unbound Engineered Nanoparticles in Occupational Settings
- WK8705: Measurement of particle size distribution of nanomaterials in suspension by Photon Correlation Spectroscopy (PCS)
- WK8997: Standard Practice for Analysis of Hemolytic Properties of Nanoparticles

- WK9326: Standard Practice for Evaluation of the Effect of Nanoparticulate Materials on the Formation of Mouse Granulocyte-Macrophage Colonies
- WK9327: Standard Practice for Evaluation of Cytotoxicity of Nanoparticulate Materials on Porcine Kidney Cells

E 2456, Terminology for Nanotechnology

This new standard is under the jurisdiction of Subcommittee E56.01 on Terminology and Nomenclature. Developing a globally relevant nanotechnology terminology standard driven by multiple stakeholder needs has been an early priority for ASTM Committee E56, which was formed in 2005. The document defines more precisely the language for nanotechnology, and thus ensure effective technical communication within the myriad fields involved in nanotechnology, as well as outreach to the public at large as products containing nanomaterials enter the marketplace.

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2.2 International Standards Organization (ISO)

2.2.1 Technical Committee on Nanotechnologies TC229

Inaugural meeting November 2005, with participation from national standards institutes of 24 ISO member countries and eight observer countries.

Scope

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

Specific tasks include developing standards for:

- Terminology and nomenclature;
- Metrology and instrumentation, including specifications for reference materials;
- Test methodologies;
- Modeling and simulation;
- Science-based health, safety, and environmental practices.

Working Group (WG) structure

WG1 Terminology and Nomenclature led by Canada

- Scope: To define and develop uniform terminology and nomenclature in the field of nanotechnologies. It is intended to facilitate communications to ensure common understanding among interested parties.

WG2 Measurement and Characterization led by Japan

- Scope: Standardization of metrology and test methods (including reference materials) which is used to characterize nano-materials and nano-structures from the aspect of physical and chemical properties.

WG3 Health, Safety and Environment led by USA

- Scope: To develop standards in the areas of health, safety, and environmental aspects of nanotechnologies

WG1 has the only active work item (BSI PAS-71).

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W:
http://www.iso.org/iso/en/stdsdevelopment/tc/tclist/TechnicalCommitteeDetailPage.TechnicalCommitteeDetail?COMMID=5932

2.3 International Electrotechnical Commission (IEC)

2.3.1 (IEC)ABN 20, Advisory Body on Nanotechnology

ABN 20 has been tasked with:

- Coordinating nanotechnology standardization in technical committees (TC) and sub-committees (SC);
- Providing guidance to the Standardization Management Board (SMB) as the technology

moves from scientific investigation to application in the market and development of product standards;

- Establishing liaison with ISO TC 229 as well as other organizations involved in nanotechnology.

2.3.2 TC113, Nanotechnology Standardization for Electrical and Electronic Products and Systems

TC113 has been tasked with:

- Preparing standards in the field of nanotechnology relevant to electricity and related technologies pertinent to IEC;
- Ensuring cooperation and preventing duplication of work with ISO TC229.

The secretariat is held by Germany.

W: http://www.iec.ch/index.html

2.4 IEEE

2.4.1 Nanotechnology Council (NTC)

The IEEE has a Nanotechnology council (NTC) an interdisciplinary group whose members are drawn from 20 IEEE Societies. NTC Nanotechnology Standards Initiative seeks to identify:

- Technologies likely to generate products and services with high commercial and/or societal value;
- Areas where new standards can aid rapid commercialization, technology transfer and market diffusion;
- People and institutions to lead and support IEEE nanotechnology standards projects.

Overall, the IEEE Nanotechnology Standards Initiative seeks to identify:

- Nanoelectronic technologies likely to generate products and services having high commercial and/or societal value;
- Areas where new standards can aid rapid commercialization, technology transfer and diffusion into the market;
- People and institutions to lead and support IEEE nanotechnology standards projects.

Current IEEE nanotechnology standards projects:

- EEE P1650™, Test Methods for Measurement of Electrical Properties of Carbon Nanotubes —approved 7 February 2006;
- IEEE P1670™, Chemical Vapor Deposition (CVD)Techniques for Nanotechnologies;

- IEEE P1690™, Standard Methods for the Characterization of Carbon Nanotubes Used as Additives in Bulk Materials;
- Nanoelectronics Standards Roadmap (NESR) initiative expected to publish final document in the first quarter of 2007.

W:

- http://grouper.ieee.org/groups/1650/ for more information on the IEEE 1650™ Working Group
- http://standards.ieee.org/announcements/pr_icnqtsg.html for information on the IEEE Carbon Nanotube Quality Testing Study Group
- http://standards.ieee.org/announcements/pr_p1670.html for information on the IEEE 1670™ Working Group
- http://standards.ieee.org/announcements/pr_nanomap.html for information on the Workshop for a Roadmap for nanoelectronics standards
- http://ewh.ieee.org/tc/nanotech/index.html for information on the IEEE Nanotechnology Council
- http://www.ieeeusa.org/policy/positions/nanotechnology.html for a legislative outlook on nanotechnology in the US at the IEEE-USA web site
- http://www.ieee.org/organizations/pubs/transactions/tnano.htm for information on "The IEEE Transactions on Nanotechnology."
- http://standards.ieee.org/ to learn more about the IEEE-Standards Association.
- http://ewh.ieee.org/tc/nanotech/

2.5 Institute of Environmental Sciences and Technology (IEST)

2.5.1 Standards and Practices Committee 7: Nanotechnologies

IEST is a voting member of TTC 229, and leads the working group ISO/TC 209 looking at the development of standards and recommended practices in the cleanroom.

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2.6 Organization for Economic Co-operation and Development (OECD)

2.6.1 Chemicals Committee

Scope

- Address the possible environmental safety and human health implications of manufactured nanomaterials;
- Develop a basis for harmonized approaches to testing and assessment of chemicals;
- increase the efficiency of national testing and assessment efforts;
- reduce non-tariff barriers to trade.

The Chemicals committee established in September 2006 the Working Party on Manufactured Nanomaterials (WPMN). This group will focus on the implications for the safety for human health and the environment of the use of nanomaterials (focussing on testing and assessment methods).

W: http://www.oecd.org/department/0,2688,en_2649_37015404_1_1_1_1_1,00.html

3 UK

3.1 British Standards Institution (BSI)

3.1.1 Nanotechnologies Standardization Committee NT/1

This committee mirrors the work of ISO/TC 229 and CEN TC/352. BSI is also the Chair and Secretariat of the International Organization for Standardization's (ISO) technical committee for nanotechnologies.

Scope:

- Formulate UK strategy for nanotech standardization through broad consultation with stakeholders,
- Ensure the UK view is given due consideration within the European Union, CEN and ISO;•
- Develop and support formal standards and other standardization documents in nanotechnologies and to promote their use;
- Promote and coordinate standardization consideration by UK nanotechnology networks and organizations

The first project was the Publicly Available Specification (PAS) for nanoparticulate vocabulary recently published by the British Standards Institution (BSI). This will support the development of a common language framework for academics, industry, regulators and governments to use. It was developed with International cooperation and has been disseminated widely to date.

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3.2 National Physical Laboratory (NPL)

3.2.1 Measurements for Emerging Technologies (MET)

NPL run the Measurements for Emerging Technologies (MET) programme which has 2.5m being committed by Government and Industry for nanoparticulate work.

W: http://www.metprog.org.uk/

4 EUROPE

4.1 Deutsches institut fur Normung (DIN)

4.1.1 DIN/DKE Steering Committee on Nanotechnology

DIN is the German Institute for Standardization. DKE is the national organization responsible for the creation and maintenance of standards and safety specifications covering the areas of electrical engineering, electronics and information technology in Germany. The DKE is a joint organization of DIN and the VDE. The VDE is responsible for the daily operations of the DKE.

The DIN/DKE Steering Committee on Nanotechnology which mirrors the work of ISO/TC 229 and CEN TC/352. It also plays a key role in the EU project NANO STRAND (Standardization Related to R&D for Nanotechnologies), the goal of which is to develop roadmaps for European Standardization and associated pre-normative research.

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4.2 Association Francasie de Normalisation (AFNOR)

4.2.1 X457 Nanotechnologies

X457 Nanotechnologies focus mirrors that of ISO TC 229 and European Committee for Standardization (CEN) TC/352.

Scope:

- Terminology and nomenclature;
- Measurement and characterization;
- Health, safety and environment.

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4.3 European Committee for Standardization (CEN)

4.3.1 CEN TC/352Nanotechnologies

CEN and ISO TCs work collaboratively. CEN TC/352 focuses on topics not addressed in ISO TC 229. It was established November 2005 following recommendation from CEN/BT/WG 166

Scope

Standardization in the field of nanotechnologies that includes either or both of the following:

- 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, and 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. The Secretariat is held by BSI.

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W: http://www.cenorm.be/cenorm/index.htm

4.4 EC

4.4.1 7th Framework Programme

Nanosciences, Nanotechnologies, Materials and new Production Technologies – NMP, is a priority area in the 7th framework programme. The following areas cover standards:

NMP-2007-1.2-4: Coordination in nanometrology

Technical content/scope: Nanosciences and nanotechnologies are rapidly growing on the one hand due to their great potential in terms of developing new products and processes, and on the other hand due to the continuous development of analytical and manipulation equipment that make operating at the nanoscale possible. However, challenges are also great, in particular since many researchers and industries are involved, and precision, accuracy, repeatability and reproducibility of measurement, analysis and methods are not yet reliably consolidated. A Europe-wide effort is therefore required bringing together interested leading centres. This will

allow precious synergy to be achieved in Europe and valuable output for the scientific and industrial communities.

This coordination action should address the identification and co-ordination of top-class activities carried out in Europe in the field on nanometrology and particularly for the (i) characterisation of reactions, materials, mechanisms, structures and systems at the nano-level, and (ii) performance assessment and improvement of methodology, operational praxis and use of equipment. Aspects focusing on measuring health, safety and environmental impact of nanotechnology do not need to be specifically considered within this coordination action.

Further issues such as nomenclature, specific metrology, harmonisation work and pre-normative research for potential standards, (certified) reference materials, intellectual property rights should be addressed, as well as dedicated education and training, and the service to industry and particularly to SMEs. This action should take into account relevant existing and ongoing activities, and be complementary to them.

Funding scheme: Coordination and support actions aiming at coordinating research activities.

Specific features: Collaboration with CEN TC 352 is encouraged and appropriate exchange of information at international level may also be considered. Expected impact: (i) Capacity building in Europe in nanometrology; (ii) improved reliability of measurement and analysis at the nano-level; (iii) support to the development of new nanotechnology-based products and industrial processes, to their reliability, safety and future commercialisation on the global market; (iv) support to research and regulation; (v) sustainable development; (vi) implementation of the European Commission's Action Plan for Nanotechnology; (vii) elements relevant to establishing the creation of one (or more) leading pole(s) of excellence that will be able to support industrial activities, in particular benefiting high-tech SMEs.

NMP-2007-2.1-3: Characterisation of nanostructured materials

Technical content/scope: The field of nanostructured materials has witnessed quite remarkable progress in recent years, with many different types of nanomaterials being synthesized for potentially wide industrial applications. Advanced characterisation methods to determine their structure and properties are essential for the development and processing of these nanostructured materials. Moreover, many new characterisation techniques are not well known or are unaffordable for SMEs active in nanomaterial production. European-wide efforts are needed to compile the characterisation techniques that are in use or should be developed to support further nanomaterial development, in particular, the design of intrinsically safe nanomaterials. The coordination actions should focus on the identification and co-ordination at European level of dissemination and development actions to allow researchers and nanomaterial producers, in particular SMEs, to be well aware of the state-of-the-art in characterisation tools for

nanostructured materials. Harmonisation work for potential standards in the field of characterisation of nanostructured materials should also be considered.

Funding scheme: Coordination and support actions aiming at coordinating research activities.

Special features: None

Expected impact: Dissemination of novel techniques and preparation of standards in the field of nanomaterials characterisation. For example, it is very common for nanoparticles to be characterised only in terms of particle size (SEM) and reactivity (specific surface) with no consideration of the structure-properties relationship at the relevant length scale. This is even more pronounced if nanocomposites, hybrid systems and interface behaviour are considered. Increased take up of nanomaterial characterisation methods beyond using just particle size and reactivity would be expected in particular for SMEs. Development of, or preparatory work for, new standards in the field of characterisation of nanostructured materials.

4.4.2 Nanosafe

Safe Production and Use of Nanomaterials

An EU project to develop risk assessment and management for secure industrial production of nanoparticles .Nanosafe 2 is an integrated project covering a large number of technical areas:

- Subproject 1: Detection and characterization techniques
- Subproject 2: Health hazard assessment
- Subproject 3: Development of secure industrial production systems
- Subproject 4: Environmental & societal aspects

W: www.nanosafe.org

4.4.3 Nano-Strand

LNE, the French National Metrology Laboratory, is coordinating this project, entitled Standardization related to Research and Development for Nanotechnologies, or Nano-Strand. The main objectives of Nano-strand are initially to identify the needs, expectations and priorities of all players concerned and to determine who can best meet them, in order to subsequently draw up a road map for European standardization. The road map will also provide research topics for the 7th EU Research Framework Programme (FP7).

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5 NORTH AMERICA

5.1 American National Standards Institute

5.1.1 Nanotechnology Standards Panel (NSP)

NSP serves as the cross-sector coordinating body for purposes of developing standards in the area of nanotechnology including, but not limited to:

- Nomenclature/terminology;
- Materials properties;
- Testing, measurement and characterization procedures.

The panel holds secretariat of ISO TC 229 Working Group(WG3) on Health, Safety and Environment.

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W: http://www.ansi.org/standards_activities/standards_boards_panels/nsp/overview.aspx?menuid=3

5.2 Standards Council of Canada

The council is the governor of ISO TC 229 Working Group (WG1) on Terminology and Nomenclature.

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5.3 International Council on Nanotechnology (ICON)

ICON is run by Rice University to examine the potential environmental and health risks of nanotechnology, thereby fostering risk reduction while maximizing societal benefit. There is a wealth of information regarding safety aspects of nanotechnology on their website.

They have produced a Review of Safety Practices in the Nanotechnology Industry: http://cohesion.rice.edu/CentersAndInst/ICON/emplibrary/Phase%20I%20Report_UCSB_ICON%20Final.pdf, and a Survey of Current Practices In the Nanotechnology WorkPlace

W: http://icon.rice.edu/

6 ASIA

6.1 Asia-Pacific EconomicCooperation (APEC)

6.1.1 Industrial Science and Technology Working Group (ISTWG)

This group's participants agreed the most urgent needs for nanoscale measurement are in the areas of consumer products and nanoparticles. The group has proposed the development of a three-year pan-Asian project to develop a roadmap for nano scale metrology and standards.

W:
http://www.apec.org/apec/apec_groups/working_groups/industrial_science_and_technology.html

6.2 Industrial Technology Research Institute (ITRI) Nanotechnology Research Center and Center for Measurement Standards

ITRI initiated NANOMARK, a nano products certification system with first six companies certified in December 2005. See http://www.nanomark.itri.org.tw/Eng/.

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6.3 Japan National Institute of Advanced Industrial Science and Technology (AIST)

AIST leads the Japanese standardization and risk efforts. Full details are available at http://www.nanoworld.jp/apnw/articles/library3/pdf/3-39.pdf. AIST has disseminated standards for:

- Calibration of size-measurement instruments;
- Calibration of instruments for particle number/density;
- Standards for simultaneous measurement of particle size and number density

6.3.1 Research Center for Chemical Risk Management (CRM)

The Research Center for Chemical Risk Management works with government and industry to promote environmental safety through science-based and sustainable solutions, and disseminates research findings and recommendations about risk assessment and risk management to the general public and policymakers.

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6.4 Japan Industrial Standards Committee (JISC)

6.4.1 Council on Nanotechnology Standards in Japan

The council mirrors the work of ISO TC 229. Current activities include plans to submit two New Works in Progress (NWIPs) relating to the characterization of fullerenes and carbon nanotubes by end of 2006. They are drafting an International Standardization Roadmap for Nanotechnology along with the Nanotechnology Business Creation Initiative (NBCI). NBCI is currently determining Japanese industry perspectives relating to international nanotechnology standards activities. Secretariat is held by AIST.

Subcommittees:

- Terminology and Nomenclature
- Metrology and Monitoring
- Environment and Safety

W: http://www.nbci.jp/

6.5 Ministry of Economy, Trade and Industry (METI)

In November 2004, the Ministry of Economy, Trade and Industry, or METI (which is the JISC secretariat), established a study group, the Committee for Nanotechnology Standardization Research and Study, in cooperation with the Japanese Standards Association. In April 2005, METI announced the launch of a three-year project to address R&D for the standardization of evaluation methods on the safety of nanoparticles under its R&D for International Standardization Program. The budget for the first year of this project is about 30 million Japanese yen (about US $300,000).

6.6 Korean Agency for Technology and Standards (KATS)

6.6.1 Materials and Nanotechnology Standards Division

Includes the following research groups:

- Synthesis of standard samples;
- Standardization of purity measurements;
- Evaluation of mechanical and physical properties of CNTs;
- Standardization of CNT-field emission displays (FED) performance;
- Standardization of purification procedures.

6.7 Ministry of Commerce, Industry and Energy (MOCIE)

MOCIE has established a 5-year project for nanotechnology standardization (US$2 million/year). They have also signed memorandum of understanding (MOU) with National Institute of Standards and Technology (NIST) in the USA for nano-bio interdisciplinary technology.

6.8 Standardization Administration of China

6.8.1 SAC/TC279, Committee on Nanotechnology

Scope:

- Nomenclature
- Product specifications
- Test Methods

In April 2005, seven standards were released.

- GB/T19619-2004 Terminology for nanomaterials
- GB/T13221-2004 Nanometer powder - Determination of particle size distribution - Small angle X-ray scattering method (ISO/TS13762, Particle size analysis - Small angle x-ray scattering method, MOD)
- GB/T19587-2004 Determination of the specific surface area of solids by gas absorption using the BET method (ISO 9277:1999, NEQ)
- GB/T19588-2004 Nano-nickel power
- GB/T19589-2004 Nano-zinc oxide
- GB/T19590-2004 Nano-calcium carbonate
- GB/T19591-2004 Nano-titanium dioxide
- GB/T19627-2005 Particle size analysis - Photon correlation spectroscopy (ISO 13321:1996,IDT)

According to Ministry officials, 20 new nanotechnology-related standards are expected in the near future. New Standard GB/T 20307-2006, General Rules for Nanometer Scale Length Measurement by SEM was approved July 2006 and is scheduled for publication in February 2007

Contact:

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VP of Chinese Academy o f Sciences and China’s National Center for Nano science and Nanotechnology (NCNST)

W: http://www.sac.gov.cn/

7 FURTHER READING AND USEFUL WEBSITES

Reports

- Safety aspects of nanotechnology, http://cordis.europa.eu/nanotechnology/src/safety.htm
- Strategic Plan for NIOSH Nanotechnology Research, Filling the Knowledge Gaps, http://www.cdc.gov/niosh/topics/nanotech/pdfs/NIOSH_Nanotech_Strategic_Plan.pdf
- Industrial application of nanomaterials - chances and risks (Band 54), Hrsg.: VDI-Technologiezentrum; 2004, http://www.vdi.de/vdi/organisation/schnellauswahl/techno/arbeitsgebiete/zukunft/sub/10803/index.php

Websites

- ASTM International and Committee E56:http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?E+mystore and http://www.astm.org/cgi-bin/SoftCart.exe/COMMIT/COMMITTEE/E56.htm?L+mystore+ivol7954
- International Electrochemical Commission (IEC):http://www.iec.ch/
- International Standards Organization (ISO) and TC 229 Nanotechnologies:http://www.iso.org/iso/en/ISOOnline.frontpage andhttp://www.iso.org/iso/en/stdsdevelopment/tc/tclist/TechnicalCommitteeDetailPage.TechnicalCommitteeDetail?COMMID=5932
- Institute of Electrical and Electronics Engineers (IEEE)and Nanotech Council (NTC):http://ewh.ieee.org/tc/nanotech/ and http://standards.ieee.org/announcements/bkgnd_nanostdsinit.html
- Institute of Environmental Sciences and Technologies (IEST):http://www.iest.org/
- Semiconductor Equipment and Materials International(SEMI):http://www.semi.org
- Japan Industrial Standards Committee (JISC):http://www.jisc.go.jp
- Asia-Pacific Economic Cooperation (APEC) and Industrial Science and Technology Working Group(ISTWG):http://www.apec.org/ andhttp://www.apec.org/apec/apec_groups/working_groups/industrial_science_and_technology.html
- Industrial Technology Research Institute (ITRI)Nanotechnology Research Center (NTRC) and Center for Measurement Standards (CMS):http://www.ntrc.itri.org.tw/eng/index.jsp andhttp://www.itri.org.tw/eng/itri-labs/index.jsp

- Japan National Institute of Advanced Industrial Science and Technology (AIST) and Nano Particle RiskProject:http://unit.aist.go.jp/nanotech/index.html andhttp://www.nanoworld.jp/apnw/articles/library3/pdf/3-39.pdf
- Japan Ministry of Economy, Trade and Industry (METI):http://www.meti.go.jp/english/newtopics/data/n030417e.html
- Korea Ministry of Commerce, Industry and Energy(MOCIE):http://www.mocie.go.kr/index.jsp
- Standardization Administration of China (SAC):http://www.sac.gov.cn/
- Japan Nanotechnology Business Creation Initiative(NBCI):http://www.nbci.jp
- Japan AIST Research Center for Chemical Risk Management (CRM):http://unit.aist.go.jp/crm/
- Association Française de Normalisation (AFNOR):http://www.afnor.fr/portail.asp
- British Standards Institution (BSI) and Nano particles pecification:http://www.bsi-global.com/emergingtechnologies/Nano/index.xalter and http://www.bsi-global.com/Manufacturing/Nano/index.xalter
- Deutsches Institut für Normung (DIN):http://www2.din.de/Deutsche Kommission Elektrotechnik (DKE) Elektronic Informations-technik im DIN und VDE:http://www.dke.de/dke/
- Standards Council of Canada:http://www.scc.ca
- European Committee for Standardization (CEN):http://www.cenorm.be/cenorm/index.htm
- American National Standards Institute (ANSI)Nanotechnology Standards Panel (NSP):http://www.ansi.org/ and http://www.ansi.org/standards_activities/standards_boards_panels/nsp/overview.aspx?menuid=3National Research Council Canada (NRC)
- Institute for National Measurement Standards (INMS):http://inms-ienm.nrc-cnrc.gc.ca/en/main_e.php