ANSI-NSP Newsletter Volume V, Issue I ● April 2019

The ANSI-NSP Newsletter provides information on nanotechnology standards and related topics of interest. Stakeholders are encouraged to submit information to the ANSI-NSP that they feel would be of interest to the larger ANSI-NSP Community.

While ANSI will be providing some of the content to be included in this newsletter, this is a community-driven project, with developers and organizations providing updates on any documents published or upcoming meetings that may be of interest to the ANSI-NSP. If you do have any information you would like to share, please feel free to forward it to hbenko@ansi.org.

For further information and updates on the Panel, please visit the ANSI-NSP Website.

WELCOME

When ANSI established its Nanotechnology Standards Panel in 2004 (www.ansi.org/nsp), the promise of nanotechnology was limitless: An almost $3 trillion dollar industry by 2015 which would give us space elevators made of carbon nanotube cables, more targeted and effective drug delivery systems and high-strength, low-weight material that would revolutionize transportation and infrastructure**.** While some of its early-on promises might now be seen as hype, nanotechnology-based processes and applications, along with the utilization of nanomaterials in composites and products, is now a common reality in the marketplace.

As the technology advances, the needs of the community have changed relative to those standards required to ensure its successful implementation. Many of the "foundational" nanotechnology standards needs, as identified by original ISO/TC 229 Chair Dr. Peter Hatto: What you call it (terminology); How you

measure it (metrology); and What is its impact (health, safety, environment), are now established and being used as the basis with which the nanotechnology community further considers and develops industry-specific standards.

As the ANSI-NSP enters its 15th year, it is an appropriate time to reflect on the work done to progress the development of consensus, science-based standards for nanotechnology; it is also an opportune time to look towards the future, to determine how the standards community can continue to help the commercialization of nanotechnology-related processes, applications and materials. Our Guest Columnist, Dr. Denis Koltsov, Chair of the International Organization for Standardization's (ISO) Technical Committee (TC) 229 *Nanotechnologies*, provides a valuable retrospective on one of the most active standards organizations in this space.

ISO/TC 229 *NANOTECHNOLOGIES* – A LOOK BACK – Dr. Denis Koltsov, Chair, ISO/TC 229 *Nanotechnologies*

It's been nearly 15 years since the creation of one of the largest and among the most prolific nanotechnology committees ISO Technical Committee 229 on *Nanotechnologies* (ISO/TC 229). Looking back at our first steps of developing terminology and some of the early guidelines it was hard to predict then the size of the work programme we have today. It was recognized in the early days of ISO/TC 229 that improvements were needed in the terminology used by nanotechnologists resulting in work on a set of standardized terms. Having laid down the fundamentals in terminology in the form of the ISO/IEC 80004 series the activity then shifted to measurement and characterisation. Experts recognized a need for more consistent approaches to how nanomaterials were characterized because rather than seeking common methodologies researchers often used methods they were used to or that were readily available. Driven by metrology and physical-chemical characterisation requirements for modern nanomaterials supply chains and, where needed, regulatory compliance, the characterisation activity at joint working group 2 (JWG2) has reached 24 documents under development. This also includes 5 graphene-related documents that cover all aspects of structural and chemical graphene characterisation.

One of the key activities of ISO/TC 229 focuses on the health and environmental aspects of nanomaterials, which corresponds well with international developments in the Organization for Economic Cooperation and Development (OECD)'s Working Party on Manufactured Nanomaterials and other organisations which also contribute to our work. Due to the growth in volumes of those nanomaterials used in the supply chains a question of material specification raised the profile of the working group 4. Their activity keeps on growing and we anticipate it to get busier for the next few years.

Another development trend is that of development of standards for various applications of nanotechnology. This work lends itself to the development of performance-based standards to foster innovation, transparency and clear communication with consumers. It is worth following the activities of this working group 5 in its efforts to advance standardisation for certain applications of nanotechnology and nanomaterials, while recognizing that not all applications can be standardized at present due to the novelty of the whole area and the lack of consensus in some application fields.

Consumer and sustainability issues are also systematically considered part of ISO/TC 229's efforts and placed the Committee's work at the forefront of UN sustainability targets implementation. The ISO/TC 229 task group, Sustainability, consumer and societal dimensions of nanotechnologies (SCASD) serves as an internal guidepost to remind all of us in ISO/TC 229 that the work we do has implications beyond the organizations that participate in the committee.

In addition to the work done by representatives to ISO/TC 229 the committee also benefits from the work being done by standards organizations at the country level. Many ISO/TC 229 projects are started within individual countries and in some cases are fully developed before they are brought to ISO/TC 229 to be considered for international use. We greatly appreciate these contributions, including those who participate on the ANSI's Nanotechnology Standards Panel. We would also welcome greater participation by experts from various nanotechnology-related communities.

Finally, it is a real pleasure to work with such a diverse and dedicated group of experts. I am very much looking forward to our meetings this year in Australia and China where we expect over 150 attendees from 29 countries and liaison organisations.

NEWS & INFORMATION

Please visit the Nanotechnology Standards Database for more information regarding both published standards as well as documents under development.

ASTM E56 Committee on Nanotechnology

ASTM International Technical Committee E56 on Nanotechnology will hold its next meeting in Denver, Colorado, on May 13-14, 2019. Several new standards including two on Reporting the Physical and Chemical Characteristics of Nano-Objects will be discussed:

WK58112 New Guide for Reporting the Physical and Chemical Characteristics of Nano-objects
1.1 This guide provides guidelines for a description system for reporting the physical and chemical characteristics of nano-objects. It establishes essential and desirable information categories and descriptors useful in describing nano-objects uniquely and such that the equivalency of two or more nano-objects can be determined to be equivalent according to specific criteria. 1.2 This guide is designed to be directly applicable to reporting the physical and chemical characteristics of nano-objects in every circumstance, including but not limited to report original research results in the archival literature, development of ontologies, database schemas, data reporting formats, specification of regulations, and commercial activity. 1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. 1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

WK62977 Reporting the Physical and Chemical Characteristics of Collections of Nano-objects -

1.1 This guide provides guidelines for a description system to report the physical and chemical characteristics of collections of nano-objects. It establishes information categories and descriptors useful in describing nano-object collections uniquely and such that the equivalency of two or more nano-object collections can be determined according to specific criteria. 1.2 This guide is designed to be directly applicable to reporting the physical and chemical characteristics of collections of nano-objects in most circumstance, including but not limited to report original research results in the archival literature, development of ontologies and database schemas, data reporting formats, specification of regulations, and commercial activity. 1.3 This guide is applicable to both naturally-occurring and engineered collections of nano-objects. 1.4 One goal of the guide is to help ensure that when measurement results are reported, they are reported uniformly. 1.5 A second goal of the guide is to encourage reports on the properties and functionalities of a nano-object collection to include as much detail as possible about the physical and chemical characteristics of that collection, so it is uniquely specified. 1.6 This guide does not cover the chemical reactions or reactivity of a nano-object collection. 1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. 1.8 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

If you are interested in learning more about the work of ASTM E56, please contact Kate Chalfin at kchalfin@astm.org.

IEC TC 113 *Nanotechnology for electrotechnical products and systems*

The following IEC TC 113 documents were published in 2018, have been approved and awaiting publication, or are in development:

Published in 2018

IEC TS 62565-4-2 ED1 (2018-05-24)

Nanomanufacturing - Material specifications - Part 4-2: Luminescent nanomaterials - Detail specification for general lighting and display applications

This Technical Specification, a USNC-led effort, specifies the essential general and optical requirements of monodisperse luminescent nanomaterials used in general lighting and display products to enable their reliable mass production and quality control during the manufacturing process.

IEC TS 62607-4-6 ED1 (2018-02-08)

Nanomanufacturing-Key control characteristics - Part 4-6: Nano-enabled electrical energy storage devices - Determination of carbon content for nano electrode materials, infrared absorption method

This Technical Specification describes a method for determining the carbon content in nano electrode materials with carbon concentrations ranging from 0,001 % (m/m) to 100 % (m/m) by combusting the materials in an induction furnace and performing infrared absorption spectroscopy measurement on the combustion by-products.

IEC TS 62607-4-7 ED 1 (2018-08-29)

Nanomanufacturing - Key control characteristics - Part 4-7: Anode nanomaterials for nano-enabled electrical energy storage- Determination of magnetic impurities, ICP-OES method

This Technical Specification provides a method for the determination of magnetic impurities in anode nanomaterials for energy storage device using Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES), including measurement overview, reagents, apparatus, test procedures, test results and test report. It applies to the determination of the total content of magnetic impurities (iron, cobalt, chromium, and nickel) which can be attracted by magnet more than 0,02 mg/kg.

IEC TS 62876-2-1 ED 1 (2018-08-29)

Nanotechnology - Reliability assessment - Part 2-1: Nano-enabled photovoltaic - Stability test

This technical specification establishes a general stability testing program to verify the stability of the performance of nanomaterials and nano-enabled photovoltaic devices (NePV) devices, when used as subassemblies for the fabrication of photovoltaic modules through a combination with other components.

In development:

IEC TS 62565-1 ED1

Nanomanufacturing - Material specifications, Part 1 - Basic concept

This Technical Specification provides guidelines which defines and describes the system of IEC specifications for nano-enabled products used in the value adding chain of nanomanufacturing. This includes all kinds of nanomaterials and nano-subassemblies described by a consensus-based set of key control characteristics (KCCs). It explains the concept of blank detail specifications, sectional blank detail specifications and detail specifications within IEC 62565 series as well as their interaction which each other. Circulate of the first Committee Draft is expected in March, 2018.

IEC 62565-3-1 ED1

Nanomanufacturing - Material specifications - Part 3-1: Graphene - Blank detail specification

This standard, a USNC-led project, will establish a blank detail specification and format for listing essential electrical and certain other characteristics including optical, dimensional, and mechanical properties of single and few layer and functionalized graphene for use in electrotechnical applications. The CDV will be circulated later this year.

IEC TS 62565-3-2

Nanomanufacturing - Material specifications - Part 3-2: Graphene - Sectional blank detail specification for nano-ink

This Technical Specification provides guidance on how to list, define and measure key characteristics of graphene based inks intended for use in electrotechnical applications. Standard methods for characterization and evaluation of both the graphene based inks and resulting films made from these inks are specified. The first Committee Draft is expected in the spring.

IEC TS 62565-4-1 ED1

Nanomanufacturing – Key control characteristics – Part 4-1: Luminescent nanomaterials – Blank detail specification

This standard, a USNC-led project, will establish a blank detail specification and format for listing essential optical and certain other characteristics of monodisperse nanomaterials that luminesce including optical nanomaterials, which will enable the customer to specify requirements in a standardized manner and to verify through standardized methods that the nanomaterial meets the required properties. The CDV is expected to be circulated in the spring.

IEC TS 62607-2-4 ED1

Nanomanufacturing - Key control characteristics - Part 2-4: Carbon nanotube materials - Accuracy and repeatability of test methods for determination of resistance of individual carbon nanotubes

This Technical Specification specifies the test method for determining the resistivity and the contact resistance of an individual CNT and the dependability of the measurement. The Draft Technical Specification is in development.

IEC TS 62607-3-3 ED1

Nanomanufacturing–Key control characteristics–Part 3-3: Luminescent nanomaterials - Determination of fluorescence lifetime using Time Correlated Single Photon Counting (TCSPC)

This Technical Specification provides a standardized method for determining the fluorescence lifetime of luminescent nanomaterials using the time correlated single photon counting methods (TCSPC). The TCSPC method is suitable for testing fluorescence lifetime in the range from picoseconds to microseconds. It provides users a key control characteristic to decide whether or not luminescent nanomaterials, such as quantum dots (QDs), clusters, organic dyes etc. are usable or suitable for their application. Comments on the Committee Draft will be resolved at the spring 2019 WG10 meeting in Madrid.

IEC TS 62607-4-8

Nanomanufacturing - Key control characteristics – Part 4-8: Nano-enabled electrical energy storage - Determination of water content for electrode nanomaterials by the Karl Fischer Method

This Technical Specification provides a method for the determination of water content as a quality control test, which can affect electrical, cycling and safety performance of nano-enabled electrical energy storage devices. This is currently in the Committee Draft stage with comments to be resolved at the spring WG11 meeting in Madrid.

IEC TS 62607-5-2 ED1

Nanomanufacturing - Key control characteristics - Part 5-2: Thin-film organic/nano electronic devices - Measuring Alternating Current characteristics

This Technical Specification specifies a standard procedure for measuring AC characteristics as a stability test based on the measurement of frequency-dependent hysteresis in current-voltage characteristics of OTFTs. The first Committee Draft is being prepared.

IEC TS 62607-5-3 ED1

Nanomanufacturing – Key control characteristics - Part 5-3: Thin-film organic/nano electronic devices – Measurements of charge carrier concentration

This Technical Specification, specifies a standard procedure for measuring a wide range of charge carrier concentration in organic/nano materials. The standardized procedure is based on both Hall-effect measurement with van der Pauw configuration and capacitance-voltage (C-V) measurement in metal/insulator/semiconductor stacking structures. Comments on the first Committee Draft will be resolved at the spring 2019 WG7 meeting in Madrid.

IEC TS 62607-6-1 ED1

Nanomanufacturing - Key control characteristics - Part 6-1: Graphene - Measurement of sheet resistance of commercial graphene powders by the Four Probe Method

This Technical Specification establishes a method for conductivity measurements of graphene powders. Voting on the Draft Technical Specification closes March 29, 2019. Comments will be resolved at the spring 2019 WG8 meeting in Madrid.

IEC TS 62607-6-2 ED1

Nanomanufacturing – Key control characteristics – Part 6-2: Graphene – Evaluation of the number of layers of graphene

This Technical Specification describes methods for counting the number of layers of graphene such as atomic force microscope (AFM), transmission electron microscope (TEM), light transmittance, and Raman scattering. Circulation of the first Committee Draft is expected around May, 2018.

IEC TS 62607-6-5 ED1

Nanomanufacturing - Key control characteristics Part 6-5: Graphene - Sheet resistance and contact resistance of two-dimensional materials including graphene

This Technical Specification provides a proper definition of sheet resistivity measurement and a unit for the electrical characterization of two-dimensional materials. It includes recommended conditions for a sample preparation and the comparison of sheet resistivity unit between two-dimensional materials and conventional materials under test in the referenced background research results. Comments on the first Committee Draft are being resolved.

IEC TS 62607-6-6 ED1

Nanomanufacturing - Key control characteristics - Part 6-6: Graphene - Uniformity of strain analyzed by spatially-resolved Raman spectroscopy

This Technical Specification establishes a standardized method to determine the key control characteristic "strain uniformity" for graphene by an analysis of the width of the 2D-peak in the Raman spectrum. Strain uniformity is a figure of merit to quantify the influence of nano-scale strain variations on the electronic properties of the layer. The classification should help manufacturers to classify their material quality and customers to provide an expectation of the electronic performance of the classified graphene and more specifically to decide whether or not the graphene material quality is potentially suitable for various applications. It is due for circulation as a Draft Technical Specification.

IEC TS 62607-6-9 ED1

Nanomanufacturing - Key control Characteristics - Part 6-9: Graphene - Measurement of sheet resistance by the non-contact Eddy current method

This Technical Specification establishes a method for contactless measurement of the sheet resistance of large area graphene layers on non-conductive substrates for electrical characterization and quality control. Circulation of the Draft Technical Specification is expected around spring 2019.

IEC TS 62607-6-13 ED1

Nanomanufacturing – Key control characteristics – Part 6-13: Determination of Oxygen Functional Groups Content of Graphene Materials with Boehm titration method

This Technical Specification provides a standardized method for determining surface oxygen functional groups on graphene materials using the Boehm titration method, in order to quantify the surface acidic oxides of graphene materials, including carboxyl groups (also in the form of their cyclic anhydrides), lactone groups, hydroxyl groups and reactive carbonyl groups. It provides a standardized method that is suitable to graphene materials prepared by oxidation-reduction method, solution-phase exfoliation, micro mechanical exfoliation and organic synthesis. Voting on the Draft Technical Specification closes March 29, 2019. Comments will be resolved at the spring 2019 WG8 meeting in Madrid.

IEC TS 62607-6-14 ED1

Nanomanufacturing – Key control characteristics – Part 6-14: Graphene –Defect level analysis in graphene powder using Raman spectroscopy

This Technical Specification sets guidelines to evaluate the defect level in graphene powder by the intensity ratio of the D+D' band and 2D band in Raman spectrum, which helps graphene manufacturers classify their material quality. The first Committee Draft closed in early 2019. Comments will be resolved at the spring 2019 WG8 meeting in Madrid.

IEC TS 62607-7-2 ED1

Nanomanufacturing - Key Control Characteristics - Part 7-2: Nano-enabled photovoltaics - Device evaluation method for indoor light

This Technical Specification specifies the efficiency testing of photovoltaic cells (excluding multi-junction cells) under indoor light. Although it is primarily intended for nano-enabled photovoltaic cells (organic thin-film and DSC), it can also be applied to other types of photovoltaic cells. This is an approved new work item with appointed experts currently developing the first Committee Draft.

IEC TS 62607-8-1 ED1

IEC TS 62607-8-1: Nanomanufacturing - Key Control Characteristics - Part 8-1: Nano-enabled metal-oxide interfacial devices - Test method for defect states by thermally stimulated current

This Technical Specification specifies the measurement method for determining defect states of nano-enabled material and devices as generated by the de-trapping of charges. The first Committee Draft stage is completed. Comments will be resolved at the spring 2019 TC 113 WG meetings in Madrid.

IEC TS 62876-3-1 ED1

Nanomanufacturing - Reliability assessment - Part 3.1: Graphene - Stability test: Temperature and humidity

This Technical Specification establishes a general reliability qualification methodology for graphene layers on a substrate to demonstrate that these layers fulfil a minimum level of reliability. The described methodology will not provide full reliability data which allow the estimation of product lifetimes. A Committee Draft was circulated and closed in January, 2018. Based on resolution of the comments, a second CD will be circulated.

ISO/TC 229 *Nanotechnologies* Recent Publications and approved work items

ISO has recently published the following deliverables developed under ISO/TC 229 *Nanotechnologies*:

- **ISO/TR 12885:2018 - *Nanotechnologies — Health and safety practices in occupational settings,*** is a revision of ISO/TR 12885:2011, the first Technical Report out of ISO/TC 229 WG 3, Health safety and environment. This revision of ISO/TR 12885 describes health and safety practices in occupational settings relevant to nanotechnologies. This document focuses on the occupational manufacture and use of manufactured nano-objects, and their aggregates and agglomerates greater than 100 nm (NOAAs). It does not address health and safety issues or practices associated with NOAAs generated by natural processes, hot processes and other standard operations which unintentionally generate NOAAs, or potential consumer exposures or uses, though some of the information in this document can be relevant to those areas.

- **ISO/TS 16195:2018 – *Nanotechnologies – Specification for developing representative test materials consisting of nano-objects in dry powder form,*** a revision of ISO/TS 16195:2013, specifies development of representative test materials consisting of nano-objects in dry powder form, to enable test method development and improve comparability of data for nanotechnology applications. It includes the physico-chemical properties (specifically, size and shape, specific surface area, crystal structure, and bulk chemical composition) that are required to be measured and reported with the representative test material.

- **ISO/TR 20489:2018** – **Nanotechnologies – Sample preparation for the characterization of metal and metal-oxide nano-objects in water samples**, provides an overview of approaches of sample preparation (i.e. pre-treatment and size-fractionation) for analytical measurements applied to surface and drinking water, potentially containing relevant amounts and types of metal and metal oxide nano-objects, including collection from source and storage of samples, pre-concentration of analytes, and their fractionation.

- **ISO/TR 21386:2019 -** ***Nanotechnologies -- Considerations for the measurement of nano-objects and their aggregates and agglomerates (NOAA) in environmental matrices***, provides some considerations for the collection of environmental samples to be analysed for manufactured NOAA, considerations to distinguish manufactured NOAA from background levels of naturally occurring nanoscale particles of the same composition, and preparation procedures to aid in the quantification of manufactured NM in environmental matrices.

- **ISO/TR 19733:2019 –** ***Nanotechnologies – Matrix of properties and measurement techniques for graphene and related two-dimensional nanomaterials*****,** provides a matrix which links key properties of graphene and related two-dimensional (2D) materials to commercially available measurement techniques. The matrix includes measurement techniques to characterize chemical, physical, electrical, optical, thermal and mechanical properties of graphene and related 2D materials.

More information regarding the documents above, or any published ISO Standards or other deliverables, can be reviewed after publication using the ISO Online Browsing Platform (https://www.iso.org/obp/ui/). All ISO published documents are available for purchase via ANSI's Webstore.

ISO/TC 229 has recently added the following projects to their work programme:

- **ISO/DTS 21357** -- ***Nanotechnologies – Evaluation of the mean size of nano-objects in liquid dispersions by static multiple light scattering (SMLS)*** *(under development by JWG 2, Measurement and characterization)*
- **ISO/DTS 23459** -- ***Nanotechnologies -- Assessment of protein secondary structure following an interaction with NMs using Circular Dichroism Spectroscopy (CDS)*** (*under development by WG 3, Health, safety and environment*)

More information regarding the work items above, or any other work items included in ISO/TC 229's work programme, is available via your country's ISO Member Body. In the U.S., please contact ANSI: hbenko@ansi.org

The American National Standards Institute's Nanotechnology Standards Panel (ANSI-NSP) serves as the cross-sector coordinating body for the purposes of facilitating the development of standards in the area of nanotechnology, including, but not limited to: nomenclature/terminology; health, safety and environmental aspects; materials properties; and testing, measurement, and characterization procedures.

For more information about the NSP, please contact hbenko@ansi.org