SMB/6756/R

STRATEGIC BUSINESS PLAN (SBP)

IEC/TC or SC:	Secretariat:	Date:
IEC/TC113	**Germany**	**2018-xx-xx**

Please ensure this form is annexed to the Report to the Standardization Management Board if it has been prepared during a meeting, or sent to the Central Office promptly after its contents have been agreed by the committee.

A. State title and scope of TC

Title: TC 113 – Nanotechnology for electrotechnical products and systems

Scope: Standardization of the technologies relevant to electrotechnical products and systems in the field of nanotechnology in close cooperation with other committees of IEC and ISO.

Nanotechnology can be used in a wide variety of applications. The deliverables of TC 113 will specifically focus on the standardization needs for components or subassemblies that are created for electrical or electro-optical applications from materials and processes at the nanoscale. Potential applications include but are not limited to: Electronics; optics; magnetics; electromagnetics; electro acoustics; telecommunications; electricity generation as in fuel cells and photovoltaic devices; and energy storage devices.

Considering the platform nature of nanotechnology and to prevent competitive standardization activities of other TCs and SDOs dealing with nanotechnology and products, appropriate internal IEC TC Liaisons, ISO Liaisons and Working Group Liaisons (C-Liaison) have been established, new Liaisons will be added as needed.

The current liaisons are: ISO TC 229 JWG1: Nanotechnology - Terminology and Nomenclature; ISO TC 229 JWG2: Nanotechnology - Measurement and Characterization, ISO TC 201 Surface Chemical Analysis; IEC TC 1, TC 21, SC 21A, TC 47, TC 55, TC 82, TC 86, SC 86B, TC 111, TC 119; TC 124; C-Liaisons with IEEE, SEMI, ANF, Graphene Flagship Standardization Committee (GFSC), EMPIR-GRACE standardization Committee, National Graphene Association.

As more and more nanotechnology innovations will be transformed into viable commercial electrotechnical products, specific work activities of TC 113 are to expand to include liaisons with other appropriate TCs. However, independent of the specific market area they will be addressed under the generic topics, terminology, measurements, characterization, performance, reliability, safety and environment issues and allocated under appropriate Working Groups of the committee.

B. MANAGEMENT STRUCTURE OF THE TC

B.1 MATRIX ORGANIZATION STRUCTURE OF TC 113

In the Plenary Meeting held in Busan, KR, this SBP document was revised with modifications and confirmed including the current representation of the organizational and management structure:

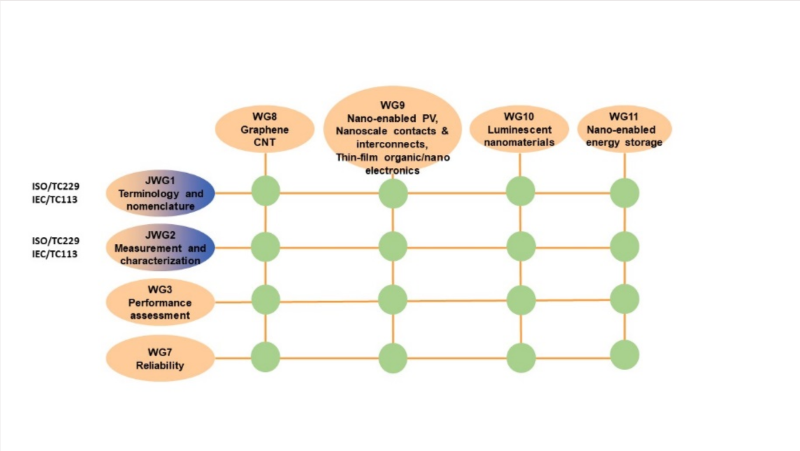

Figure 1 Matrix Organization Structure of TC 113

JWG 1: Terminology and nomenclature

Define and develop unambiguous and uniform terminology and nomenclature in the field of nanotechnologies to facilitate communication and to promote common understanding.

JWG 2: Measurement and characterization

The development of standards for measurement, characterization and test methods for nanotechnologies, taking into consideration needs for metrology and reference materials.

WG 3: Performance assessment

To develop standards for the assessment of performance, reliability, and durability related to the nanotechnology-enabled aspects of components and systems in support of continuous improvement at all stages of the value adding chain. WG 3 considers market demand and technology pull with an emphasis on fabrication, processing and process control, disposal, and recycling. In addition, WG 3 has a cross sectional function to ensure the consistency of performance standard developed in WGs 8,9,10 and 11.

AG 4: Chairman Advisory Group (CAG)

WG 7: Reliability

To develop standards for the assessment of reliability in the field of nano electro technology. The focus is on failure mechanisms and failure modes related to the use of nanomaterials, nanostructures, material interfaces and nanoscale contacts with consideration of size dependent effects. Standards to be developed include test methods to identify failure mechanisms, analyse failure effects and estimate the reliability (i.e. the early fail rate, measure in units of parts per million in the first 1000h of operation) and the durability of nano-enabled products, i.e. the fit rate (1 fit = 1 fail in 10^9 hours of operation).

WG 8: Graphene related materials, Carbon nanotube materials

To develop standards within the area of carbon nanotube materials and graphene related materials Graphene related materials includes graphene and its modifications as well as other 2D materials. Those standards are intended to facilitate the assurance of quality and reliability of materials and intermediates, subject to the general concepts of blank detail specifications (BDS) and Key Control Characteristics (KCCs).

WG 9: Nano-enabled photovoltaics, Thin-film organic/nano electronics, Nanoscale contacts and interconnects

To develop standards in the area of nano-enabled photovoltaics and organic electronics to facilitate the assurance of quality and reliability of materials and intermediates, subject to the general concepts of blank detail specifications (BDS) and Key Control Characteristics (KCCs). Furthermore the WG is responsible for standardization in the area of nano-scale contacts and interconnects.

WG 10: Luminescent nanomaterials

To develop standards within the field of luminescent nanomaterials, which include quantum dots, dyeincorporated matrix nanoparticles, up-conversion nanoparticles, rare earth luminescent nanomaterials and others, with a focus on key control characteristics and test methods for performance, reliability, stability and others related to fabrication, processing and process control, disposal, recycling, etc.

WG 11: Nano-enabled energy storage

To develop standards within the key nanotechnology area nano-enabled energy storage, to facilitate the assurance of quality and reliability of materials and intermediates, subject to the general concepts of blank detail specifications (BDS) and Key Control Characteristics (KCCs).

Category A Liaisons:

Internal IEC Liaisons: TC 1, TC 21, SC 21A, TC 47, TC 55, TC 82, SC 86B, TC 111, TC 119, TC 124

ISO Liaison: TC 229: JWG1 and JWG2; TC 201

Category C Liaisons:

IEEE, SEMI, ANF, GFSC, EMPIR-GRACE, National Graphene Association

B.2 Management review of the structure

The Management structure will be reviewed every 3 or 4 years. Details on its development history are provided below:

During the period 2006 - 2014, the structure of TC 113 consisted of:

- Joint Working Groups (JWG) with ISO TC 229 Nanotechnology
  - JWG1: Terminology and Nomenclature;
  - JWG2: Measurement and Characterization);
  - WG 3: Performance Assessment);
  - AG 4: Chairman Advisory Group (CAG);
  - AG 5: Advisory Group on Environment, Health and Safety; and
  - AG 6: Advisory Group on Printed Electronics

In subsequent years, the CAG, established[1] to assist the Chairman in tasks concerning coordination, planning and steering of the committee's work or other specific tasks of an advisory nature, had presented several recommendations to TC 113 which were approved by the Plenary Sessions:

- In the 9th Plenary Meeting held in Tokyo, the establishment of WG 7 to develop standards for the assessment of reliability in the field of nano electro technology was confirmed.
- In the 9th Plenary Meeting held in Tokyo, TC 113 confirmed to follow a matrix organization structure with the formation of WG 8, WG 9, WG 10, WG 11 to address the Market and Technology verticals and the existing JWG 1, JWG 2, WG 3 and WG 7 Product Development and Manufacturing horizontals (Figure 1).
- The standardization process in each key nanotechnology area revolves around central documents:
  - Blank Detail Specification (BDS: 62565-x-y): The BDS lists all properties of the nanomaterial which are potentially relevant to the quality of the nano-enabled product;
  - Key Control Characteristics (KCC: 62607-x-y): The KCC document deals with the standardized measurement procedures to measure the relevant properties compiled in the BDS;
  - The BDS and KCC standards are structured in an analogous manner to company internal standards which are used in the implementation of Quality Management Systems. Therefore, BDS: 62565-x-y and KCC: 62607-x-y are expected to make the documents most useful for its stakeholders since they will facilitate the continuous improvement of the quality of nanomaterials and nano-enabled products[1].

[1] W. Bergholz: „Quality Management and Reliability for Nano-enabled Materials and Products“, in „Quality Management in Technology“, J. Wittmann and W. Bergholz eds, 2018

- Each standard is developed by experts from the Technology verticals who meet in one working group (WG 8, WG 9, WG 10, WG 11) ensuring the high quality of the content of the documents, while at the same time enabling the overall harmonization of projects regarding for a standardization area (JWG 1, JWG 2, WG 3, WG 7).

- In the 12th Plenary Meeting held in Frankfurt, it was confirmed to (regarding graphene projects) to be allocated in WG 8

- AG 5 was disbanded at the Milpitas meeting in 2012 because the expected need of the group was not confirmed. The task of AG 5 was transferred to a newly committed liaison officer to ISO/TC 229/WG 3.

- AG 6 was disbanded because the IEC decided to establish the new technical committee TC 119 on printed electronics. TC 113 and TC 119 identified a significant overlap of their technical responsibilities especially in the material area because nanomaterials are widely used in printed electronics. A close liaison with the secretaries as the liaison officers was subsequently established to prevent double work and inconsistent standards.

- In the 13th Plenary Meeting held in Shenzhen, TC 113 confirmed the D-Liaison (now designated as C liaisons, due to a change in the directives) with Graphene Flagship Standards Committee (GFSC)

- In the 14th Plenary Meeting held in Busan, TC 113 confirmed liaisons with ISO TC 201 and IEC TC 124.

- In the 14th Plenary Meeting held in Busan, TC 113 confirmed C-liaisons with EMPIR-GRACE and National Graphene Association.

C. BUSINESS ENVIRONMENT

Nanotechnology is one of the key platform technologies of the 21st century. Nanomaterials serve as potential building blocks for nanoscale electronics, optoelectronics and photonics. The nanoelectronics industry is expected to see economic growth in photovoltaic products, displays, sensors, and lighting, RFID (Market Outlook for Nanomaterials for Electronics, Research and Markets, ID2691709, Dec 2017).

The electronics market is emphasizing on the development of more nanoelectronics components such as lightweight photovoltaic cells, biosensors, molecular memory, etc. The market is usually segmented by product types or material types into nanowires, nanofibers, carbon nanotubes, nanoparticles such as copper, silver and gold, graphene and other 2-dimensional materials. It is also segmented by application type such as coatings, lighting, displays, energy storage, photovoltaic cells, coatings and films, electronic packaging, data storage, processing and others. The electronics industry will witness a significant change and growth in the next decade driven by scaling, growth of mobile devices, IoT and ubiquitous electronics made possible by flexible, stretchable and printable electronics (The Global Market for Nanoelectronics (Nanotechnology in Electronics, Research and Markets, ID4239008, May 2017))

Electronics products with the greatest degree of acceptance in the marketplace are those based on performance standards. The electronics industry is affected by these myriad standards and the SDOs (industry based associations, national, regional and international organizations) that produce and endorse them. Also, standards for product safety are generally prescribed by each country’s own national SDOs. However, the economic reality of world trade increases the relevance of international standards.

D. Market Demand

It is considered most important that the documents to be developed by TC 113 align to fulfil the demanding quality standard of the electronics industry. Quality cannot be tested into a product, but it should result from manufacturing the product by stable processes with as little process variability as economically feasible and reasonable. The amazing quality improvements achieved by the microelectronics industry over the last 4 decades have been made possible by the deployment of quality engineering tools such as Quality Function Deployment (QFD), process management, statistical process control (SPC), supply chain management and other quality engineering tool throughout the whole value chain.

Therefore, quality management (QM) tools must be deployed in nanoelectronics standardization enabling nanofabrication of high quality components and sub-assemblies. These tools are applicable for all three approaches conventionally used for nanofabrication: (i) horizontal approach involving nanomaterials synthesis, (ii) bottom-up approach of self-assembly of novel 3D or 2D materials and (iii) top-down approach involving nano structuring.

Owing to the complexities of the horizontal platform nature of nanotechnology, it would be advantageous to have the participatory standards promoting and accelerating early commercialization; and at the same time supporting the societal acceptance of nanotechnology. Hence, risk management and control procedures in various phases of the material and product development become equally important.

The specification documents (Blank Detail Specification, Sector Blank Detail Specification and Detail Specification) are intended to be the key QM tools for this market sector. These QM tools together with the standards on Key Control Characteristics (KCC) and reliability assessments are needed by the nanomaterial and component suppliers and device integrators. They provide one easy standards-portal access for the electronics products research and development, scale-up manufacturing, finished device testing and certification.

The matrix structure of the WGs and the liaison activities support the QM system and tools needed to sustain the growth of this promising market and are conducive to increasing its societal acceptance. A roadmap of graphene standardization activities (Figure 2) is provided below for graphene as a demonstrating example of how TC 113 addresses the needs of various stakeholders:

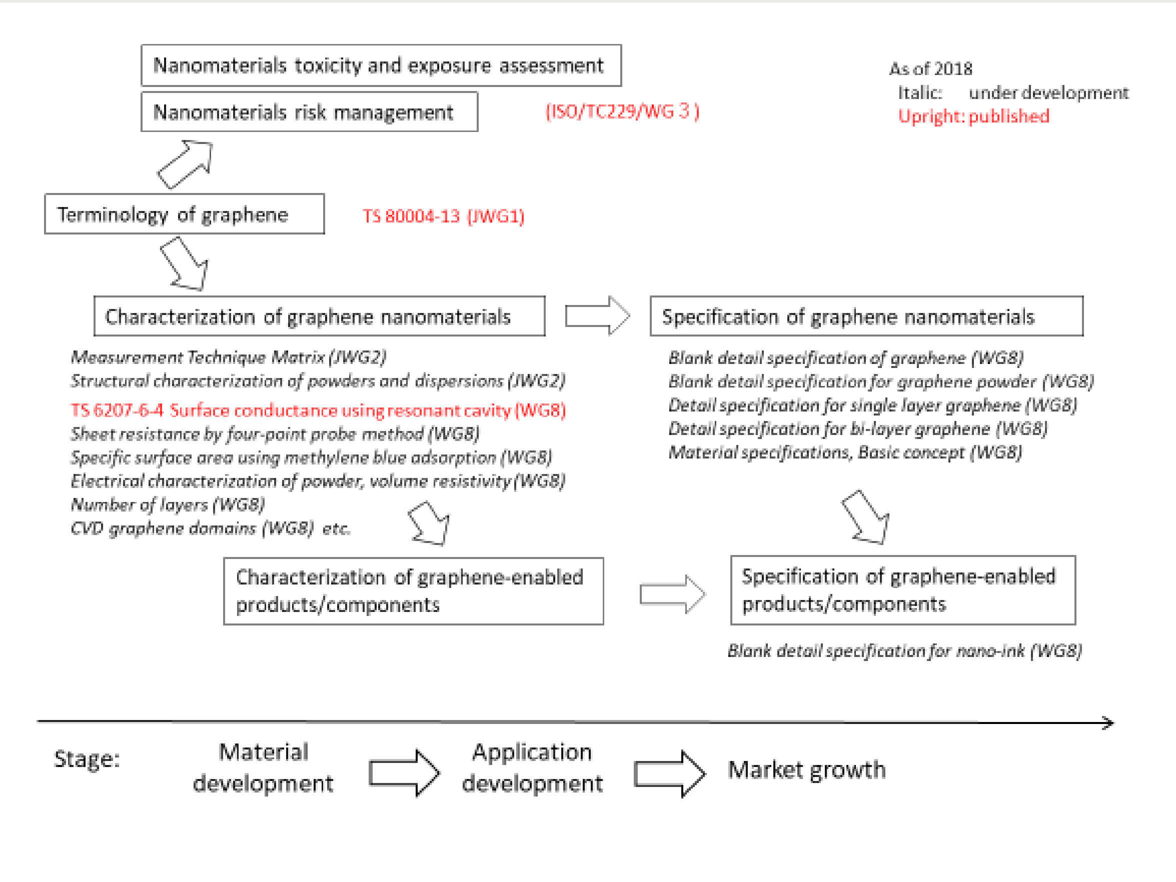

Figure 2: An example of a TC 113 standardization roadmap to support the market

E. TRENDS IN TECHNOLOGY AND IN THE MARKET

E1 GENERAL APPROACH

Nanotechnology enables the development of new products that are covered by many IEC TCs/SCs. An IEC Nanoelectronics Standards Roadmap will be the foundation for a standardization strategy for nano-electro-technologies. It reflects the trends in the technology and expected market developments.

A survey on standardization needs was conducted in 2008 in cooperation with NIST (USA), with input from technical experts worldwide. A Project Team was subsequently authorized in 2009 to develop an IEC Nanoelectronics Standards Roadmap. The result of this work was published as an IEC Technical Report IEC/TR 62834. The primary focus of this TR was nanomaterials for electrotechnical applications (carbon nanotube (CNT), luminescent nanomaterials, graphene, etc.) and nanoscale devices (nanoscale contacts CNT interconnects, nano transistors, large area electronics etc.) markets. Since its publication, the document served TC 113 in setting up priorities for initiation of new projects by its members. Currently, the document is under maintenance.

TC 113 was also involved in a technology foresight project of the IEC Market Strategy Board SWG 2 “Market and Technology Watch – Nanotechnology in the sectors solar energy and energy storage”. This project was intended to act as a pilot project for the IEC to support “systems-oriented standards development, as well as application-oriented goal solutions defined by the market”. Published as a White Paper by IEC, it outlines a whole range of nanomaterials and nanotechnologies, specifically evaluating their role and contribution t o a successful integration of renewable energy and energy storage. The activities by TC 113 in WG 9 and WG 11 echo the benefits from this White Paper.

For the second edition of TR 62834, forecasting models using big data analysis will be used to evaluate the emergence of the keywords and hence technology trends in future N years. The emerging keyword grades and scores are provided for each keyword using more than 100 parameters such as forward citations, transactions, lawsuits, self-references, academic publications, global patent family networks, companies etc. Graphene and different forms of it, quantum dots, super capacitor, Li ion batteries, printed electronics, organic light emitting diodes are some of the emerging keyword trends with high scores in the data analysis. There is also identifiable high industry activity on graphene and graphene oxide (GO) and reduced graphene oxide (rGO).

The industry directions indicate there are two key success factors for nanoelectronics: (1) material – the future of memory is driven by materials; (2) subsystems – thin film transistors (TFT), 2D transistors (Nano Korea 2017, July 2017). Therefore, identifying key control characteristics of nano-enabled components and subsystems become very important for extending their durability and reliability. For an optimized use of nanomaterials, the size-dependent effects at the nanoscale contacts and material interfaces are critical.

E2 OTHER TRENDS

Nanotechnology has already penetrated the electronics industry and will be increasingly important in the future. Microelectronics was the economic driver for the last half of the 20th century, nanoelectronics is poised to drive the first half of the 21st century.

The major directions for the future are in an (i) increased focus on carbon based devices, (ii) increased focus on non-IT applications such as energy, healthcare, IoE, always connectivity and mobile devices and (iii) increased focus on spin, magnetics, magnetic tunnel junctions, especially spin torque based structures.

The area of nano-magnetism, has been identified as new work and TC 113 has started to evaluate this topic at the 2015 Seoul meeting with the establishment of a new PWI for spatially resolved local magnetic field measurements on the micrometre and nanometre scale.

F. SYSTEMS APPROACH ASPECTS (REFERENCE - AC/33/2013)

Collaboration between IEC/TC113 (Nanotechnology for electrotechnical products and systems) and ISO/TC229 (Nanotechnologies) is working, especially in the field of graphene standardization. Joint meetings have been held in the spring time.

G.	CONFORMITY ASSESSMENT
	Not yet addressed

H.	HORIZONTAL ISSUES
	Nanotechnology is horizontal by nature across industries and IEC TCs. Coordination is always considered between horizontal and vertical organizations.
I.	3-5 YEAR PROJECTED STRATEGIC OBJECTIVES, ACTIONS, TARGET DATES

STRATEGIC OBJECTIVES 3-5 YEARS	ACTIONS TO SUPPORT THE STRATEGIC OBJECTIVES	TARGET DATE(S) TO COMPLETE THE ACTIONS
Harmonization of standardization between Blank Detail Specification and Key Control Characteristics of nanomaterials	Developing standards documents on basic concept of blank detail specification and basic concept of key control characteristics	By 2022
Note: The progress on the actions should be reported in the RSMB.		