TECHNICAL SPECIFICATION

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Nanotechnologies — Vocabulary —

Part 1: Core terms

Nanotechnologies — Vocabulaire —

Partie 1: Termes "coeur"

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Foreword

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The committee responsible for this document is ISO/TC 229, *Nanotechnologies*, and Technical Committee IEC/TC 113, *Nanotechnology standardization for electrical and electronic products and systems*.

This second edition cancels and replaces the first edition (ISO/TS 80004-1:2010), which has been technically revised.

Documents in the 80000 to 89999 range of reference numbers are developed by collaboration between ISO and IEC.

ISO/TS 80004 consists of the following parts, under the general title *Nanotechnologies — Vocabulary*:

— *Part 1: Core terms*

— *Part 2: Nano-objects*

— *Part 3: Carbon nano-objects*

— *Part 4: Nanostructured materials*

— *Part 5: Nano/bio interface*

— *Part 6: Nano-object characterization*

— *Part 7: Diagnostics and therapeutics for healthcare*

— *Part 8: Nanomanufacturing processes*

The following parts are under preparation:

— *Part 9: Nano-enabled electrotechnical products and systems*

— *Part 10: Nano-enabled photonic components and systems*

— *Part 11: Nanolayer, nanocoating, nanofilm, and related terms*

— *Part 12: Quantum phenomena in nanotechnology*

— *Part 13: Graphene and other two-dimensional materials*

Introduction

By control of matter in the *nanoscale* (2.1), *nanotechnology* (2.3) brings together processes and techniques that are used to research, design and manufacture materials, devices, and systems. It enables management of characteristics such as material size, shape, morphology, chemical composition and molecular configuration for the improvement, or development of, new process and product properties.

Applications of nanotechnologies are expected to impact virtually every aspect of life and enable dramatic advances in communication, health, manufacturing, materials and knowledge-based technologies. Even if this is only partially realized, there is a need to provide industry and researchers with suitable tools to assist with the development, application and communication of nanotechnologies.

A crucial objective is the harmonization of terminology and definitions, in order to promote common understanding and consistent usage across communities where nanotechnologies are being developed and used. In the context of the ISO/TS 80004- series of standards, "terminology" refers to the following:

a) a structured or conceptual presentation of vocabulary employed in nanotechnologies,

b) assigned definitions for specific units of the language in this vocabulary.

This part of ISO/TS 80004 presents terminology and definitions for core terms in this emerging vocabulary, and serves as the foundation for a broader vocabulary constituted collectively by the ISO/TS 80004- series of standards.

As nanotechnologies continue to evolve, the terms and definitions to facilitate communications have become increasingly specific and precise. For many communities, the meaning of terms such as "nanoscale", "*nanomaterial*" (2.4) and "nanotechnology" are inferred by logical application of the SI unit of scale. The prefix 'nano-' specifically means a measure of 10^{-9} units, and the nature of this unit is determined by the word that follows. In the ISO/TS 80004 vocabulary series, however, terms such as "*nano-object*" (2.5) and "nanoscale" employ size and geometric boundaries to express fundamental and measurable aspects of nanomaterials. In the case of the term *nanoscale*, the definition acknowledges that the length range of nano-objects might fall outside the precise boundaries normally associated with the concept of scale, by indicating that the upper and lower boundaries are approximate.

The lower limit (approximately 1 nm) in the definition of nanoscale is introduced to avoid single and small groups of atoms, as well as individual molecules, from being designated as nano-objects or elements of *nanostructures* (2.6), which might be implied by the absence of a lower limit. It should also be recognized that fullerene molecules and single layer planar structures (e.g. graphene) that have dimensions below 1 nm are, in practice, considered to be nanomaterials because they are important building blocks for nanotechnology.

Further, size-dependent biological effects, specifically particle-cell interactions, and environmental interactions related to nanotechnology, involve structures below 1 nm and above 100 nm. In addition to size, the complex interplay of parameters such as aspect ratio, core chemistry, agglomeration state, physical state, surface properties and others will influence biological and environmental interactions associated with nanostructured materials.

Terminology development is proceeding at an intensive pace and needs to be responsive to the needs of stakeholders. As knowledge expands, a robust terminology will need to effectively convey not only the size and shape-based metrics of nanomaterials but also the performance-based/properties-based aspects of intentionally produced nano-objects and nanostructured materials in their definitions.

It will be an on-going challenge to communicate complex concepts in definitions in a manner that is meaningful and practical for stakeholders in research, commercial applications, government and consumer communities. It is emphasized that the definition of "nanoscale" in the ISO/TS 80004 vocabulary series is a general descriptor serving to facilitate communication concerning nanotechnologies.

The development of core terms and their definitions has benefited from discussion over time concerning scientific, regulatory and consumer usage. The science is still emerging, as is the capacity to measure

and characterize nanomaterials, or more generally matter in the nanoscale. Care needs to be taken to ensure the latest scientific information is incorporated into the terminology as it becomes available. Since the inception of ISO/TC 229 and IEC/TC 113, nanotechnology has evolved and continues to evolve. It is important to acknowledge that the associated terms and their definitions will likewise follow an evolutionary path.

Many of the definitions in this part of ISO/TS 80004 are determined to be in harmony with a framework and hierarchical system of terminology for nanotechnologies. Furthermore, it is also important to recognize that articles fabricated to contain nanomaterials are not necessarily nanomaterials themselves.

Figure 1 illustrates the relationships between "nanomaterial", "nano-object" and "*nanostructured material*" (2.7). However, this hierarchy is not intended to exclude the possibility for a nano-object to have internal or surface nanostructure. This figure should therefore be considered as schematic or idealized.

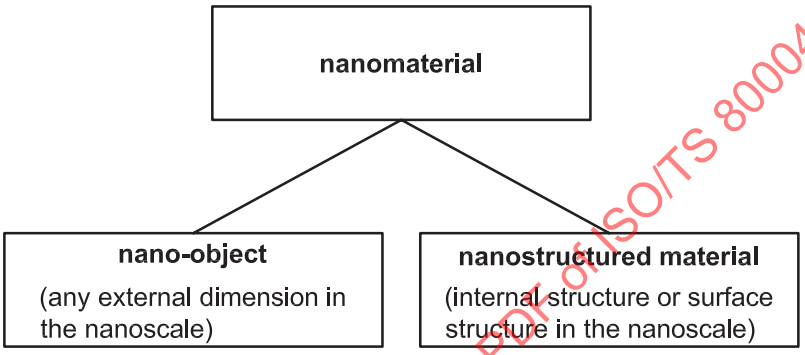

Figure 1 — Nanomaterial framework

Nanotechnologies — Vocabulary —

Part 1: Core terms

1 Scope

This part of ISO/TS 80004 lists terms and definitions related to core terms in the field of nanotechnologies. It is intended to facilitate communications between organizations and individuals in industry and those who interact with them.

2 Terms and definitions

2.1
nanoscale
length range approximately from 1 nm to 100 nm

Note 1 to entry: Properties that are not extrapolations from larger sizes are predominantly exhibited in this length range.

2.2
nanoscience
study, discovery and understanding of matter where size- and structure-dependent properties and phenomena manifest, predominantly in the *nanoscale* (2.1), distinct from those associated with individual atoms or molecules, or extrapolation from larger sizes of the same material

2.3
nanotechnology
application of scientific knowledge to manipulate and control matter predominantly in the *nanoscale* (2.1) to make use of size- and structure-dependent properties and phenomena distinct from those associated with individual atoms or molecules, or extrapolation from larger sizes of the same material

Note 1 to entry: Manipulation and control includes material synthesis.

2.4
nanomaterial
material with any external dimension in the *nanoscale* (2.1) or having internal structure or surface structure in the nanoscale

Note 1 to entry: This generic term is inclusive of *nano-object* (2.5) and *nanostructured material* (2.7).

Note 2 to entry: See also definitions 2.8 to 2.10.

2.5
nano-object
discrete piece of material with one, two or three external dimensions in the nanoscale (2.1)

Note 1 to entry: The second and third external dimensions are orthogonal to the first dimension and to each other.

2.6
nanostructure
composition of inter-related constituent parts in which one or more of those parts is a *nanoscale* (2.1) region

Note 1 to entry: A region is defined by a boundary representing a discontinuity in properties.

