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Nanotehnologije - Slovar - 1. del: Temeljni izrazi in definicije (ISO/DIS 80004-1:2021)

Nanotechnologies - Vocabulary - Part 1: Core terms and definitions (ISO/DIS 80004-1:2021)

Nanotechnologien - Fachwörterverzeichnis - Teil 1: Kernbegriffe und Definitionen (ISO/DIS 80004-1:2021)

Nanotechnologies - Vocabulaire - Partie 1: Termes "coeur" et définitions (ISO/DIS 80004-1:2021)

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Nanotechnologies – Vocabulary —

Part 1: Core terms and definitions

*Nanotechnologies — Vocabulaire —
Partie 1: Termes "cœur" et définitions*

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Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 Basic terms and definitions.....	1
3.2 Terms concerning particles and assemblies of particles.....	3
3.3 Terms specific to nano-objects.....	4
3.4 Terms used in the description of nanostructured material.....	6
3.5 Terms describing categories of nanostructured material.....	6
3.6 Terms describing coatings, layers, films, freestanding films and membranes.....	6
3.7 Terms describing nanocoatings, nanolayers, nanofilms, and related terms.....	7
Annex A (informative) Additional terms and definitions	8
Annex B (informative) Terms and definitions from other ISO/TCs	10
Bibliography	15
Alphabetical index	16

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ISO/DIS 80004-1:2021(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 229 *Nanotechnologies* and Technical Committee IEC/TC 113, *Nanotechnology standardization for electrical and electronic products and systems*.

This edition cancels and replaces ISO/TS 80004-1:2015, ISO/TS 80004-2:2015, ISO/TS 80004-4:2011 and ISO/TS 80004-11:2017, which have been technically revised.

The main changes compared to the previous editions are as follows:

- ISO/TS 80004-1:2015, ISO/TS 80004-2:2015, ISO/TS 80004-4:2011 and ISO/TS 80004-11:2017 merged into one document;
- deliverable has been changed from Technical Specification (TS) to International Standard (IS)
- definition of nanostructure amended;
- term and definition for NOAA added.

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

A list of all parts in the ISO 80004 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

By control of matter in the *nanoscale* (3.1.1), *nanotechnology* (3.1.3) 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. 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 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 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 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*” (3.1.1), “*nanomaterial*” (3.1.4) and “*nanotechnology*” (3.1.3) 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*” (3.1.5) and “*nanoscale*” (3.1.1) 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* (3.1.6), 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* (3.1.7) 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.

ISO/DIS 80004-1:2021(E)

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. 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 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.

Nano-objects (for example nanoparticles, nanofibres, and nanoplates), often occur in (large) groups, rather than as isolated or distinct entities. For reasons of surface energy, such coexisting nano-objects are likely to interact. In the description of these interactions, the following terms are often used. The terms are not restricted with respect to physical size and shape. These terms are included for completeness and importance at the nanoscale

Figure 1 illustrates the relationships between “nanomaterial” (3.1.4), “nano-object” (3.1.5) and “nanostructured material” (3.1.7). 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.

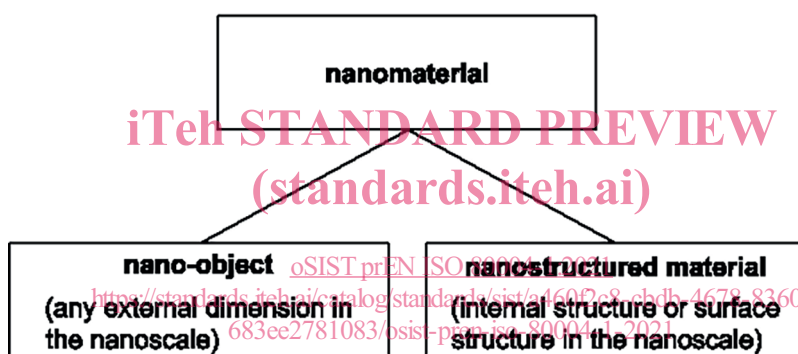


Figure 1 — Nanomaterial framework

A number of other parameters in addition to size and shape are also intrinsic to the function and phenomena exhibited by nano-objects. These parameters include composition, morphology, crystalline structure, and surface features, which can all have a major influence on the key nanoscale phenomena exhibited by nano-objects. Such phenomena include magnetic, optical, catalytic, electronic, and other properties.

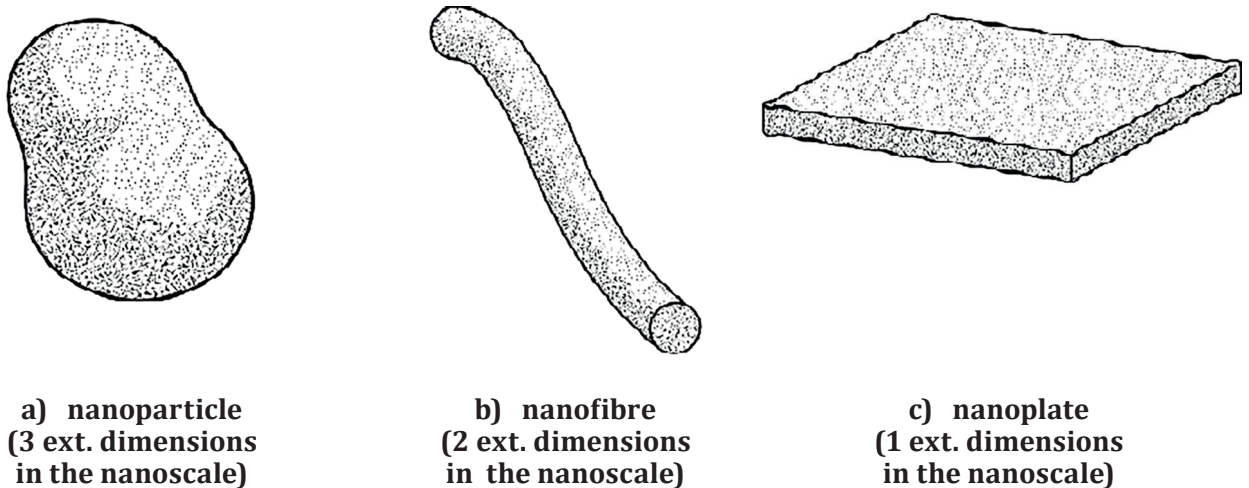


Figure 2 — Schematic diagrams showing some shapes for nano-objects

There is a hierarchical relationship between many of the different terms in this part of ISO 80004. Elements of this are shown in Figure 3 to illustrate some of the relationships that exist.

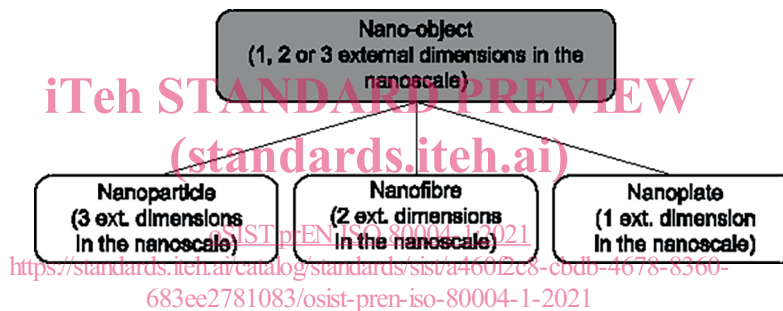


Figure 3 — Fragment of hierarchy of terms related to nano-objects

Nanostructured materials are characterized by internal structures or surface structures at the nanoscale. Nano-objects (material with one, two or three external dimensions in the nanoscale) can be nanostructured.

A material should not be classified as nanostructured based solely on its crystalline properties (three-dimensional arrangements of atoms or molecules forming a crystallite, short range order of atoms in amorphous or quasi-amorphous phases, grain boundaries, intragranular interfaces, dislocations, etc.). In contrast, materials with a grain size distribution having a significant fraction of grains in the nanoscale (nanocrystalline), voids and pores in the nanoscale, or precipitations in the nanoscale (i.e. nano-objects in a solid matrix) are sufficient features for materials to be classified as “nanostructured”. Similarly, almost all materials always have surfaces with morphological and chemical heterogeneities in the nanoscale. Only surfaces that have been intentionally modified or textured to have morphological or chemical heterogeneities in the nanoscale identify materials as “nanostructured”.

Five categories of nanostructured materials are covered in this document (see Figure 4):

- 1) powder comprising nanostructured materials
- 2) nanocomposite;
- 3) solid nanofoam;
- 4) nanoporous material;
- 5) fluid nanodispersion.

ISO/DIS 80004-1:2021(E)

For some of these five categories, a number of subcategory terms are also defined. The category and subcategory terms are not comprehensive; additional categories and subcategories will be added in later revisions of this document.

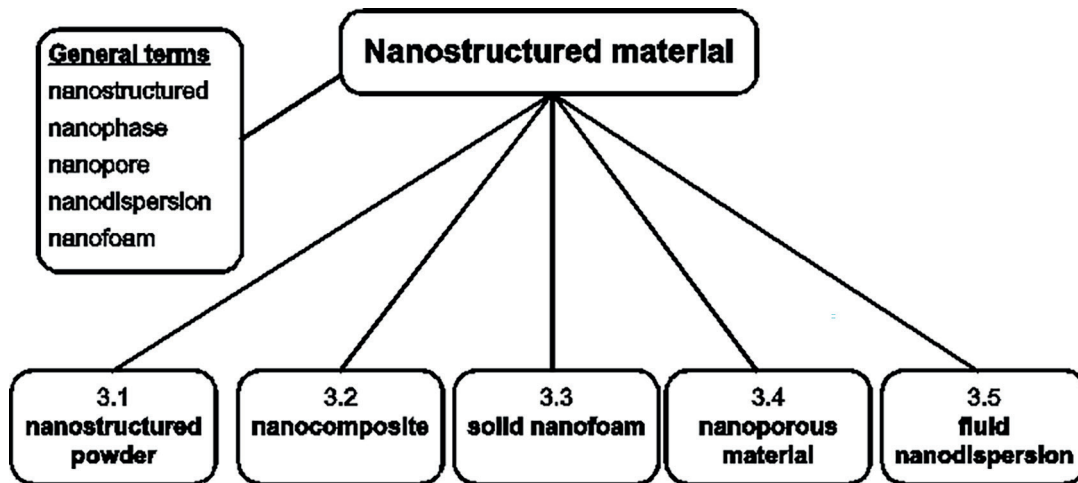


Figure 4 — Categories of nanostructured materials defined in this document

The terms coating, layer, film and others that are related can be grouped by distinguishing between coatings, layers and films having a thickness in the nanoscale (i.e. external dimension in the nanoscale) and those having internal structures in the nanoscale (e.g. nanostructured coatings, nanocomposite coatings, dispersion coatings with dispersed nano-objects, ...). Following the hierarchy established in this document which describes nanomaterial by the two categories 'nano-objects' and 'nanostructured material' the terms nanolayer, nanocoating, and nanofilm are assigned to 'nanoobjects' and the terms nanostructured layers, coatings, and films are assigned to nanostructured material (see Figure 5). It is noted that nano-objects (including nanolayers, nanocoatings and nanofilms), can be elements or parts of a larger nanostructured material.

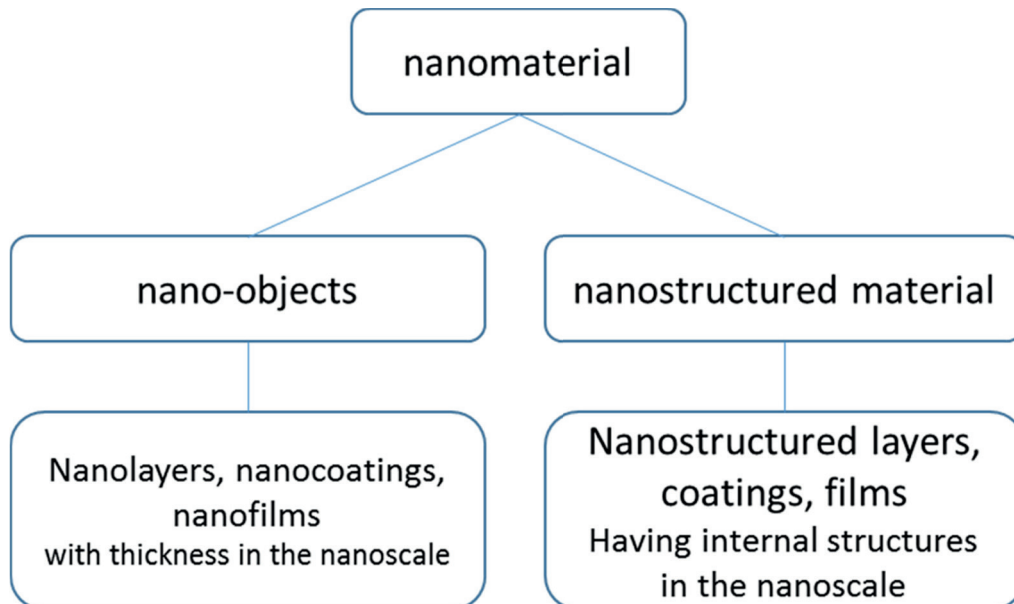


Figure 5 — Assigning the terms nanolayer, nanocoating, nanofilm to “nano-objects” and the terms nanostructured layers, coatings, and films to “nanostructured material” following the hierarchy of nanomaterial terms

Nanotechnologies – Vocabulary —

Part 1: Core terms and definitions

1 Scope

This part of ISO 80004 series 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 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Basic terms and definitions

3.1.1

nanoscale

length range approximately from 1 nm to 100 nm

3.1.2

nanoscience

study, discovery and understanding of matter where size- and structure-dependent properties and phenomena manifest, predominantly in the *nanoscale* (3.1.1), distinct from those associated with individual atoms or molecules, or extrapolation from larger sizes of the same material

3.1.3

nanotechnology

application of scientific knowledge to manipulate and control matter predominantly in the *nanoscale* (3.1.1) 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.

3.1.4

nanomaterial

material with any external dimension in the *nanoscale* (3.1.1) or having internal structure or surface structure in the nanoscale

Note 1 to entry: See also definitions 3.1.8 to 3.1.10.

Note 2 to entry: The nanoform of a material is a nanomaterial.