भारतीय मानक

Indian Standard

IS 17003 (Part 1) : 2024
ISO 80004-1 : 2023

[Superseding IS 17003 (Part 2) : 2018/ ISO/TS 80004-2 : 2015 & IS/ISO/TS 80004-4 : 2011]

नैनो प्रौद्योगिकी — शब्दावली

भाग 1 मूल शब्दावली

(दूसरा पुनरीक्षण)

Nanotechnologies — Vocabulary

Part 1 Core Vocabulary

(Second Revision)

ICS 01.040.07; 07.120

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

October 2024 **Price Group 9**

Nanotechnologies Sectional Committee, MTD 33

NATIONAL FOREWORD

This Indian Standard (Second Revision) which is identical to ISO 80004-1 : 2023 'Nanotechnologies – Vocabulary — Part 1: Core vocabulary' issued by the International Organization for Standardization (ISO), was adopted by the Bureau of Indian Standards on the recommendation of Corrosion Protection and Finishes Sectional Committee and approval of the Metallurgical Engineering Division Council.

This standard was first published in 2013 as IS/ISO/TS 80004-1 : 2010 'Nanotechnologies — Vocabulary — Part 1: Core terms' under single numbering system. Later, some parts of ISO/TS 80004 series were adopted under dual numbering system of IS series IS 17003. Thus, the first revision of this standard was brought out in 2022 to align with ISO/TS 80004-1 : 2015 'Nanotechnologies — Vocabulary — Part 1: Core terms' under dual numbering system. This revision has been brought out to align with the latest version ISO 80004-1 : 2023 'Nanotechnologies — Vocabulary — Part 1: Core vocabulary' to harmonize it with the latest developments that have taken place at international level.

ISO/TS 80004-1 : 2023 was revised by ISO by merger of ISO/TS 80004-1 : 2015, ISO/TS 80004-2 : 2015, ISO/TS 80004-4 : 2011 and ISO/TS 80004-11 : 2017 and subsequently these four standards were withdrawn by ISO. Three of these standards, ISO/TS 80004-1 : 2015, ISO/TS 80004-2 : 2015 and ISO/TS 80004-4 : 2011 were adopted as Indian Standards as IS 17003 (Part 1) : 2015/ISO/TS 80004-1 : 2015, IS 17003 (Part 2) : 2018/ISO/TS 80004-2 : 2015 and IS/ISO/TS 80004-4 : 2011 respectively.

This revision superseds IS 17003 (Part 2) : 2018 and ISO/TS 80004-2 : 2015 and IS/ISO/TS 80004-4 : 2011.

This standard is published in seven parts. Other parts in the series of ISO/TS 80004 which are adopted as Indian standards are:

Parts	*Title*	*Adopted as*
Part 3	Carbon nano-objects	IS 17003 (Part 3) : 2022/ ISO 80004-3 : 2020
Part 5	Nano bio interface	IS/ISO/TS 80004-5 : 2011
Part 6	Nano-object characterization	IS 17003 (Part 6) : 2024/ ISO/TS 80004-6 : 2021
Part 7	Diagnostics and therapeutics for healthcare	IS/ISO/TS 80004-7 : 2011
Part 8	Nano manufacturing processes	IS 17003 (Part 8) : 2022/ ISO 80004-8 : 2020
Part 13	Graphene and related two-dimensional (2D) materials	IS 17003 (Part 13) : 2022/ ISO/TS 80004-13 : 2017

The text of ISO standard has been approved as suitable for publication as in Indian Standard without deviations. Certain terminologies and conventions are, however, not identical with those used in Indian Standard. Attention is especially drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, it should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker while in Indian Standards the current practice is to use a point (.) as the decimal marker.

(*Continued on third cover*)

Contents

Page

Introduction

By control of matter in the nanoscale, nanotechnology 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, “terminology” refers to:

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

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

This document 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.

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 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 80004 series, however, terms such as nano-object 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 can 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, which can 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, 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 80004 series is a general descriptor serving to facilitate communication concerning nanotechnologies.

The development of core terms and their definitions has benefited from discussions 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 document 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 (e.g. 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. 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, nano-object and nanostructured material. However, this hierarchy is not intended to exclude the possibility for a nano-object to have internal or surface nanostructure. Figure 1 should therefore be considered as schematic or idealized.

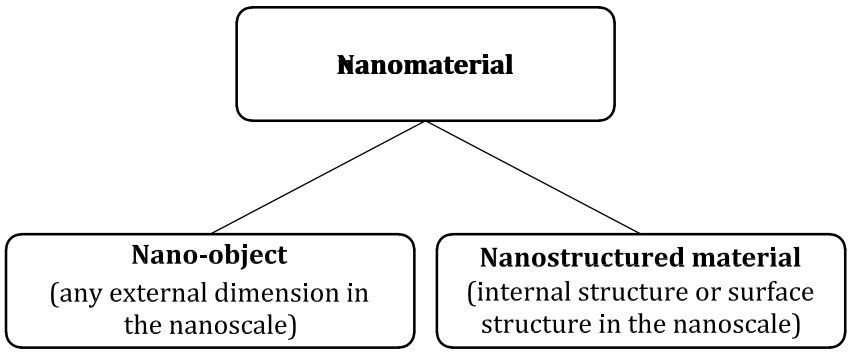
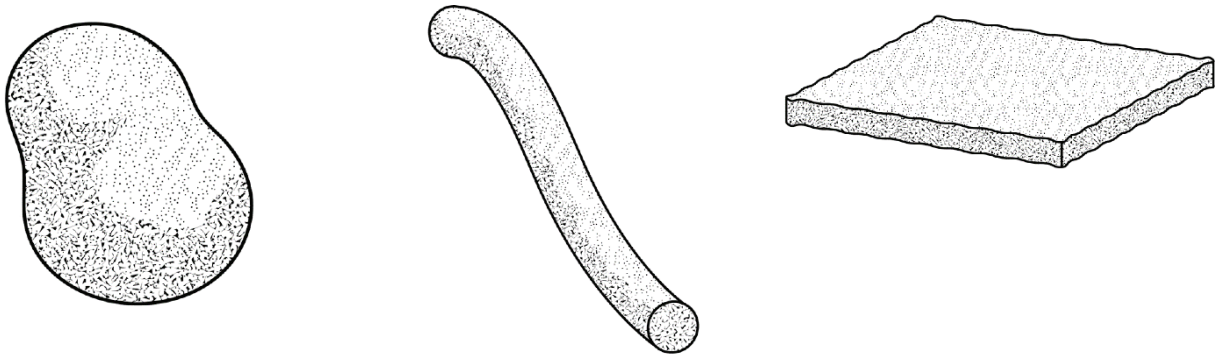


Figure 1 — Nanomaterial framework

A number of other parameters in addition to size and shape are also intrinsic to the function and phenomena exhibited by nano-objects (see Figure 2). 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.



a) Nanoparticle (3 external dimensions in the nanoscale)

b) Nanofibre (2 external dimensions in the nanoscale)

c) Nanoplate (1 external dimension in the nanoscale)

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

There is a hierarchical relationship between many of the different terms in this document, elements of which are shown in Figure 3.

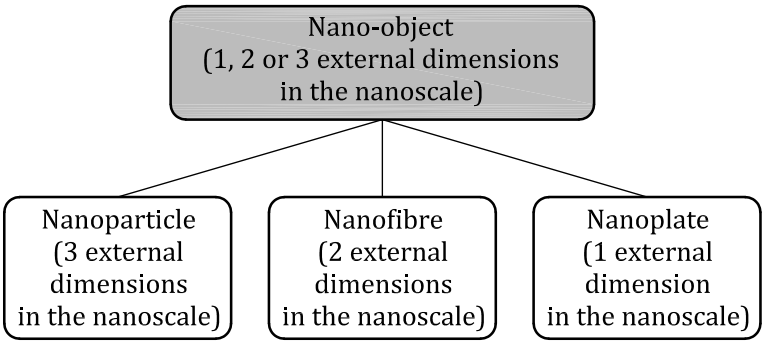


Figure 3 — Fragment of hierarchy of terms related to nano-objects

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 qualify materials as “nanostructured”.

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

a) nanostructured powder;

b) nanocomposite;

c) solid nanofoam;

d) nanoporous material;

e) fluid nanodispersion.

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.

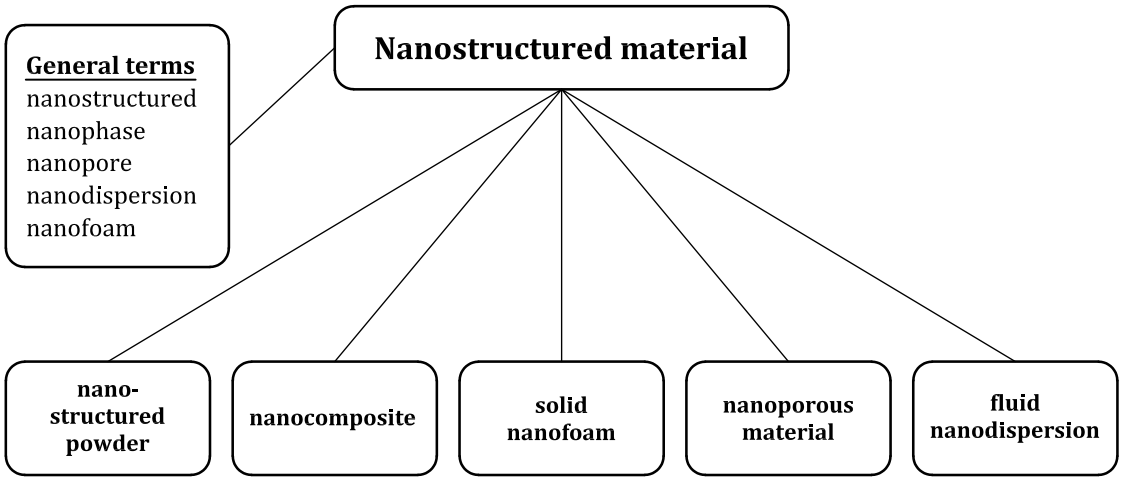


Figure 4 — Categories of nanostructured materials defined in this document

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 'nano-objects' 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.

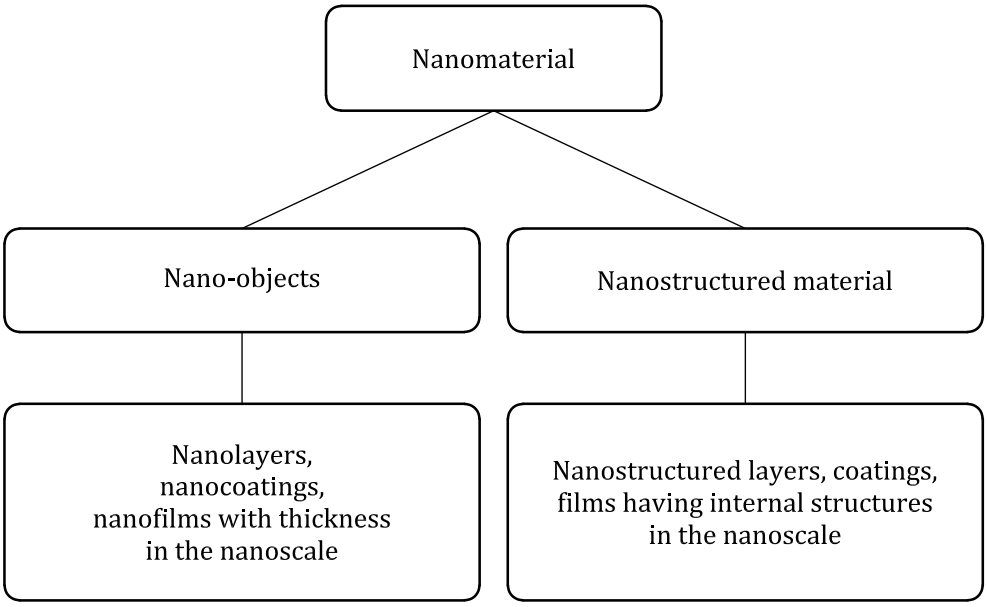


Figure 5 — Assigning the terms nanolayer, nanocoating, nanofilm to "nano-objects" and the terms nanostructured layers, coatings, and films to "nanostructured material" following the hierarchy of nanomaterial terms

Some of the terms defined in this document are also used in other industries. Keeping in mind their special applications, these industries can have slightly different definitions for those terms. In the case of

— pigments, dyestuffs and extenders, ISO 18451-1 can be consulted,

— paints and varnishes, ISO 4618 can be consulted, and

— cleanrooms and associated controlled environments, ISO 14644-3 can be consulted.

These references are available in the ISO online browsing platform.

Indian Standard

NANOTECHNOLOGIES — VOCABULARY

PART 1 CORE VOCABULARY

(Second Revision)

1 Scope

This document defines core terms in the field of nanotechnology. This document is intended to facilitate communication 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

ISO and IEC maintain terminology 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 Core terms related to nanotechnologies

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 include, for example, material synthesis and processing.

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 3.1.8 to 3.1.10 for definitions of certain types of nanomaterial.

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

3.1.5
nano-object
discrete piece of material with one, two or three external dimensions in the *nanoscale* (3.1.1)

3.1.6
nanostructure
surface or internal feature with one or more dimensions in the *nanoscale* (3.1.1)

Note 1 to entry: A feature includes but is not limited to *nano-objects* (3.1.5), structures, morphologies or other identifiable areas of nanoscale dimensions. For example, the nanostructure can be a nanopore or a solid feature on an object.

3.1.7
nanostructured material
material having internal *nanostructure* (3.1.6) or surface nanostructure

Note 1 to entry: This definition does not exclude the possibility for a *nano-object* (3.1.5) to have internal structure or surface structure. If external dimension(s) are in the *nanoscale* (3.1.1), the term nano-object is recommended.

3.1.8
engineered nanomaterial
nanomaterial (3.1.4) designed for specific purpose or function

3.1.9
manufactured nanomaterial
nanomaterial (3.1.4) intentionally produced to have selected properties or composition

3.1.10
incidental nanomaterial
nanomaterial (3.1.4) generated as an unintentional by-product of a process

Note 1 to entry: The process includes manufacturing, biotechnological or other processes, including natural processes.

Note 2 to entry: Incidental nanomaterial is also used as a synonym for “ultrafine particle” in ISO/TR 27628:2007.

3.1.11
nanomanufacturing
intentional synthesis, generation or control of *nanomaterials* (3.1.4)

3.1.12
nanomanufacturing process
ensemble of activities to intentionally synthesize, generate or control *nanomaterials* (3.1.4)

3.1.13
nanoscale phenomenon
effect attributed to the presence of *nanomaterial* (3.1.4) or interactions at the *nanoscale* (3.1.1)

3.1.14
nano-enabled
exhibiting function or performance only possible with *nanotechnology* (3.1.3)

3.1.15
nano-enhanced
exhibiting function or performance intensified or improved by *nanotechnology* (3.1.3)

3.1.16
nanocoating
coating (3.6.6) with thickness in the *nanoscale* (3.1.1)

3.1.17
nanocomposite
solid comprising a mixture of two or more phase-separated materials, one or more being *nanophase* (3.4.2)

Note 1 to entry: Gaseous nanophases are excluded [they are covered by *nanoporous material* (3.5.1)] from nanocomposite.

Note 2 to entry: Materials with *nanoscale* (3.1.1) phases formed by precipitation alone are not considered to be nanocomposite materials.

3.1.18
nanodispersion
material in which *nano-objects* (3.1.5) or a *nanophase* (3.4.2) are dispersed in a continuous phase of a different composition

3.1.18.1
nano-emulsion
fluid nanodispersion (3.8.2) with at least one liquid *nanophase* (3.4.2)

3.1.18.2
nanosuspension
fluid nanodispersion (3.8.2) where the dispersed phase is a solid

Note 1 to entry: The use of the term "nanosuspension" carries no implication regarding thermodynamic stability.

3.2 Terms related to particles and assemblies of particles

3.2.1
particle
minute piece of matter with defined physical boundaries

Note 1 to entry: A physical boundary can also be described as an interface.

Note 2 to entry: This general particle definition applies to *nano-objects* (3.1.5).

[SOURCE: ISO 26824:2022, 3.1.1, modified — Note 2 to entry has been deleted.]

3.2.2
primary particle
original source *particle* (3.2.1) of *agglomerates* (3.2.4) or *aggregates* (3.2.5) or mixtures of the two

Note 1 to entry: *Constituent particles* (3.2.3) of agglomerates or aggregates at a certain actual state can be primary particles, but often the constituents are aggregates.

Note 2 to entry: Agglomerates and aggregates are also termed secondary particles.

[SOURCE: ISO 26824:2022, 3.1.4]

3.2.3
constituent particle
identifiable, integral component of a larger *particle* (3.2.1)

Note 1 to entry: The constituent particle structures can be *primary particles* (3.2.2) or aggregates.

3.2.4
agglomerate
collection of weakly or medium strongly bound *particles* (3.2.1) where the resulting external surface area is similar to the sum of the surface areas of the individual components

Note 1 to entry: The forces holding an agglomerate together are weak forces, for example, van der Waals forces or simple physical entanglement.

Note 2 to entry: Agglomerates are also termed secondary particles and the original source particles are termed *primary particles* (3.2.2).

[SOURCE: ISO 26824:2022, 3.1.2]

3.2.5
aggregate
particle (3.2.1) comprising strongly bonded or fused particles where the resulting external surface area is significantly smaller than the sum of surface areas of the individual components

Note 1 to entry: The forces holding an aggregate together are strong forces, for example, covalent or ionic bonds, or those resulting from sintering or complex physical entanglement.

Note 2 to entry: Aggregates are also termed secondary particles and the original source particles are termed primary particles.

[SOURCE: ISO 26824:2022, 3.1.3, modified — Note 1 to entry has been adapted.]

3.2.6
NOAA
nano-objects and their aggregates and agglomerates
material comprising *nano-objects* (3.1.5), and their *aggregates* (3.2.5) and *agglomerates* (3.2.4)

Note 1 to entry: NOAA include structures with one, two or three external dimensions in the *nanoscale* (3.1.1), which can be spheres, fibres, tubes and others as primary structures. NOAA can consist of individual primary structures in the *nanoscale* (3.1.1) and aggregated or agglomerated structures, including those with sizes larger than 100 nm.

3.3 Terms related to nano-objects

3.3.1
engineered nano-object
nano-object (3.1.5) designed for specific purpose or function

3.3.2
manufactured nano-object
nano-object (3.1.5) intentionally produced to have selected properties or composition

3.3.3
incidental nano-object
nano-object (3.1.5) generated as an unintentional by-product of a process

Note 1 to entry: The process includes manufacturing, biotechnological or other processes, including natural processes.

3.3.4
nanoparticle
nano-object (3.1.5) with all external dimensions in the *nanoscale* (3.1.1)

Note 1 to entry: If the dimensions differ significantly (typically by more than three times), terms such as *nanofibre* (3.3.5) or *nanoplate* (3.3.6) are preferred to the term nanoparticle.

3.3.5
nanofibre
nano-object (3.1.5) with two external dimensions in the *nanoscale* (3.1.1) and the third dimension significantly larger

Note 1 to entry: The largest external dimension is not necessarily in the nanoscale.

3.3.6
nanoplate
nano-object (3.1.5) with one external dimension in the *nanoscale* (3.1.1) and the other two external dimensions significantly larger

Note 1 to entry: The larger external dimensions are not necessarily in the nanoscale.

3.3.6.1
nanoflake
nanoplate (3.3.6) with limited lateral dimensions

3.3.6.2
nanofoil
nanosheet
nanoplate (3.3.6) with extended lateral dimensions

Note 1 to entry: Nanofoil and nanosheet are used synonymously in specific industries.

Note 2 to entry: Nanofoil and nanosheet extend further with respect to their length and width compared to *nanoplate* (3.3.6) or *nanoflake* (3.3.6.1).

3.3.7
nanorod
solid *nanofibre* (3.3.5)

3.3.8
nanotube
hollow *nanofibre* (3.3.5)

3.3.9
nanowire
electrically conducting or semi-conducting *nanofibre* (3.3.5)

3.3.10
nanoribbon
nanotape
nanoplate (3.3.6) with the two larger dimensions significantly different from each other

[SOURCE: ISO/TS 80004-3:2020, 3.1.12, modified — Note 1 to entry has been deleted.]

3.3.11
nanosphere
spherical *nano-object* (3.1.5)

3.3.12
nano-onion
spheroidal *nanoparticle* (3.3.4) with a concentric multiple shell structure

[SOURCE: ISO/TS 80004-3:2020, 3.1.10]

3.3.13
core-shell nanoparticle
nanoparticle (3.3.4) consisting of a core and shell(s)

Note 1 to entry: A related term, *nanostructured core-shell particle,* is defined in 3.8.14.

Note 2 to entry: The largest external dimension and length (core diameter plus shell thickness) shall be in the *nanoscale* (3.1.1). For spherical core-shell nanoparticle, this length is the outer diameter.

3.3.14
nanocone
cone-shaped *nanofibre* (3.3.5) or *nanoparticle* (3.3.4)

[SOURCE: ISO/TS 80004-3:2020, 3.1.11]

3.3.15
nanocrystal
nano-object (3.1.5) with a crystalline structure

3.4 Terms related to the description of nanostructured material

3.4.1
nanostructured
having internal or surface structure in the *nanoscale* (3.1.1)

Note 1 to entry: If external dimensions are in the nanoscale, the term *nano-object* (3.1.5) is recommended.

3.4.2
nanophase
physically or chemically distinct region or collective term for physically distinct regions of the same kind in a material with the discrete regions having one, two or three dimensions in the *nanoscale* (3.1.1)

Note 1 to entry: *Nano-objects* (3.1.5) embedded in another phase constitute a nanophase.

3.4.3
nanopore
cavity with at least one dimension in the *nanoscale* (3.1.1), which can contain a gas or liquid

3.5 Terms related to the categories of nanostructured material

3.5.1
nanoporous material
solid material with *nanopores* (3.4.3)

3.5.2
nanofoam
liquid or solid matrix, filled with a second, gaseous phase having *nanoscale* (3.1.1) struts and walls, or a gaseous *nanophase* (3.4.2) consisting of nanoscale bubbles, or both

3.6 Terms related to coatings, layers, films and membranes

3.6.1
film
supported or unsupported thin material that is laterally continuously connected

Note 1 to entry: The attribute “thin” is used to emphasize that the thickness of the film is much smaller than the other two dimensions.

Note 2 to entry: A film can be freestanding.

Note 3 to entry: A film can be made of solids or liquids (e.g. liquid film).

Note 4 to entry: A film can be composed of a monomolecular layer (e.g. Langmuir-Blodgett film).

3.6.2
layer
monolayer
discrete material restricted in one dimension, within or at the surface of a condensed phase

3.6.3
multilayer
system of adjacent or stacked *monolayers* (3.6.2)

3.6.4
foil
unsupported *film* (3.6.1) with uniform thickness

3.6.5
membrane
structure, having lateral dimensions much greater than its thickness, through which transfer can occur under a variety of driving forces

3.6.6
coating
adherent surface *layer* (3.6.2)

Note 1 to entry: A coating can consist of multiple layers.

Note 2 to entry: A coating is always attached to a substrate (see ISO 4618:2023, 3.245).

3.7 Terms related to nanocoatings, nanolayers, nanofilms and related terms

3.7.1
nanofilm
film (3.6.1) with thickness in the *nanoscale* (3.1.1)

Note 1 to entry: A nanofilm is a *nanolayer* (3.7.2) which can be freestanding.

Note 2 to entry: A nanofilm can be made of solids or liquids (e.g. liquid film).

Note 3 to entry: A nanofilm can be composed of a monomolecular layer (e.g. Langmuir-Blodgett film).

3.7.2
nanolayer
layer (3.6.2) of material with thickness in the *nanoscale* (3.1.1)

3.7.3
nanostructured layer
layer (3.6.2) having internal structure or surface structure in the *nanoscale* (3.1.1)

3.7.4
nanostructured coating
coating (3.6.6) having internal structure or surface structure in the *nanoscale* (3.1.1)

3.7.5
nanostructured film
film (3.6.1) having internal structure or surface structure in the *nanoscale* (3.1.1)

3.7.6
nanoporous membrane
membrane (3.6.5) having *nanopores* (3.4.3)

3.8 Supplementary terms related to nanotechnology

3.8.1
ceramic matrix nanocomposite
nanocomposite (3.1.18) with at least one major ceramic phase

3.8.2
fluid nanodispersion
heterogeneous material in which *nano-objects* (3.1.5) or a *nanophase* (3.4.2) are dispersed in a continuous fluid phase of a different composition

3.8.3
nano-aerosol
nanodispersion (3.1.18) with gaseous matrix and at least one liquid or solid *nanophase* (3.4.2) [including *nano-objects* (3.1.5)]

3.8.4
liquid nanofoam
fluid nanodispersion (3.8.2) filled with a second, gaseous *nanophase* (3.4.2), typically resulting in a material of much lower density

3.8.5
metal matrix nanocomposite
nanocomposite (3.1.17) with at least one major metallic phase

3.8.6
nanocomposite coating
solid *coating* (3.6.6) comprising a mixture of two or more phase-separated materials, with one or more phases in the *nanoscale* (3.1.1)

Note 1 to entry: Materials with nanophases formed by precipitation are included (e.g. a-C:H:Me coatings).

Note 2 to entry: See 3.1.18 for the definition of nanocomposite.

3.8.7
nanocomposite film
solid *film* (3.6.1) comprising a mixture of two or more phase-separated materials, with one or more phase in the *nanoscale* (3.1.1)

Note 1 to entry: Materials with nanophases formed by precipitation are included (e.g. a-C:H:Me coatings).

Note 2 to entry: See 3.1.17 for the definition of nanocomposite.

3.8.8
nanomembrane
membrane (3.6.5) with thickness in the *nanoscale* (3.1.1)

Note 1 to entry: A nanomembrane with pores in the nanoscale is considered as a *nanoporous material* (3.5.1).

3.8.9
nanomultilayer
multilayer (3.6.3) of a total thickness in the *nanoscale* (3.1.1)

3.8.10
nanoscale property
characteristic of a *nano-object* (3.1.5) or of the *nanoscale* (3.1.1) region

3.8.11
nanostructured agglomerate
agglomerate (3.2.4) of *nano-objects* (3.1.5) or of *nanostructured* (3.4.1) *aggregates* (3.2.5)

3.8.12
nanostructured aggregate
aggregate (3.2.5) formed from *nano-objects* (3.1.5)

Note 1 to entry: By definition, aggregates cannot easily release nano-objects.

3.8.13
nanostructured capsule
shell with *nanoscale* (3.1.1) thickness, which can enclose, fix, transport or release substances

3.8.14
nanostructured core-shell particle
particle consisting of a core and shell(s), where the diameter of the core or the thickness of the shell is in the *nanoscale* (3.1.1)

Note 1 to entry: If at least one external dimension is at the nanoscale, the term *nano-object* (3.1.5) is preferred.

3.8.15
nanostructured powder
powder comprising *nanostructured agglomerates* (3.2.4), *nanostructured aggregates* (3.2.5) or other particles of *nanostructured material* (3.1.7)

Note 1 to entry: The term "powder" is used in the sense of an assembly of discrete particles, usually less than 1 mm in size (see ISO 3252:2023, 3.1.63).

3.8.16
polymer clay nanocomposite
polymer matrix nanocomposite (3.8.17) with a *nanostructured* (3.4.1) clay phase

3.8.17
polymer matrix nanocomposite
nanocomposite (3.1.17) with at least one major polymeric phase

3.8.18
solid nanofoam
solid matrix filled with a second, gaseous phase, typically resulting in a material of much lower density, with a *nanostructured* (3.4.1) matrix, for example, having *nanoscale* (3.1.1) struts and walls, or gaseous *nanophase* (3.4.2) consisting of nanoscale bubbles [closed *nanofoam* (3.5.2)], or both

Bibliography

[1] ISO 3252:2023, *Powder metallurgy — Vocabulary*

[2] ISO 4618:2023, *Paints and varnishes — Vocabulary*

[3] ISO 14644-3, *Cleanrooms and associated controlled environments — Part 3: Test methods*

[4] ISO/TR 18401, *Nanotechnologies — Plain language explanation of selected terms from the ISO/IEC 80004 series*

[5] ISO 18451-1, *Pigments, dyestuffs and extenders — Terminology — Part 1: General terms*

[6] ISO 26824:2022, *Particle characterization of particulate systems — Vocabulary*

[7] ISO/TR 27628:2007, *Workplace atmospheres — Ultrafine, nanoparticle and nano-structured aerosols — Inhalation exposure characterization and assessment*

[8] ISO/TS 80004-3:2020, *Nanotechnologies — Vocabulary — Part 3: Carbon nano-objects*

Index

S

solid nanofoam 3.8.18

(*Concluded from second cover*)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: MTD 33 (26077).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019	265 9930
Southern	: C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	2254 1442 2254 1216
Western	: Manakalya, 5th Floor/MTNL CETTM, Technology Street, Hiranandani Gardens, Powai Mumbai 400076	25700030 25702715

Branches : AHMEDABAD, BENGALURU, BHOPAL, BHUBANESHWAR, CHANDIGARH, CHENNAI, COIMBATORE, DEHRADUN, DELHI, FARIDABAD, GHAZIABAD, GUWAHATI, HARYANA (CHANDIGARH), HUBLI, HYDERABAD, JAIPUR, JAMMU, JAMSHEDPUR, KOCHI, KOLKATA, LUCKNOW, MADURAI, MUMBAI, NAGPUR, NOIDA, PARWANOO, PATNA, PUNE, RAIPUR, RAJKOT, SURAT, VIJAYAWADA.

Published by BIS, New Delhi