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Nanotechnologies — Vocabulary

Part 6: Nano-object characterization

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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European foreword

This document (CEN ISO/TS 80004-6:2021) has been prepared by Technical Committee ISO/TC 229 "Nanotechnologies" in collaboration with Technical Committee CEN/TC 352 “Nanotechnologies” the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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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).

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This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*, in collaboration with Technical Committee IEC/TC 113, *Nanotechnology for electrotechnical products and systems* and with the European Committee for Standardization (CEN) Technical Committee CEN/TC 352, *Nanotechnologies*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO/TS 80004-6:2013), which has been technically revised throughout.

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

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Introduction

Measurement and instrumentation techniques have effectively opened the door to modern nanotechnology. Characterization is key to understanding the properties and function of all nano-objects.

Nano-object characterization involves interactions between people with different backgrounds and from different fields. Those interested in nano-object characterization might, for example, be materials scientists, biologists, chemists or physicists, and might have a background that is primarily experimental or theoretical. Those making use of the data extend beyond this group to include regulators and toxicologists. To avoid any misunderstandings, and to facilitate both comparability and the reliable exchange of information, it is essential to clarify the concepts, to establish the terms for use and to establish their definitions.

The terms are classified under the following broad headings:

— Clause 3: General terms;

— Clause 4: Terms related to size and shape measurement;

— Clause 5: Terms related to chemical analysis;

— Clause 6: Terms related to measurement of other properties.

These headings are intended as a guide only, as some techniques can determine more than one property. Subclause 4.1 lists the overarching measurands that apply to the rest of Clause 4. Other measurands are more technique-specific and are placed in the text adjacent to the technique.

It should be noted that most techniques require analysis in a non-native state and involve sample preparation, e.g. placing the nano-objects on a surface or placing them in a specific fluid or vacuum. This could change the nature of the nano-objects.

The order of the techniques in this document should not be taken to indicate a preference and the techniques listed in this document are not intended to be exhaustive. Equally, some of the techniques listed in this document are more popular than others in their usage in analysing certain properties of nano-objects. Table 1 lists alphabetically the common techniques for nano-object characterization.

Subclause 4.5 provides definitions of microscopy methods and related terms. When abbreviated terms are used, note that the final “M”, given as “microscopy”, can also mean “microscope” depending on the context. For definitions relating to the microscope, the word “method” can be replaced by the word “instrument” where that appears.

Clause 5 provides definitions of terms related to chemical analysis. For these abbreviated terms, note that the final “S”, given as “spectroscopy”, can also mean “spectrometer” depending on the context. For definitions relating to the spectrometer, the word “method” can be replaced by the word “instrument” where that appears.

This document is intended to serve as a starting reference for the vocabulary that underpins measurement and characterization efforts in the field of nanotechnologies.

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Table 1 — Alphabetical list of the common techniques for nano-object characterization

Property	Common techniques
Size	centrifugal liquid sedimentation (CLS) atomic-force microscopy (AFM) differential mobility analysing system (DMAS) dynamic light scattering (DLS) variants of inductively coupled plasma mass spectrometry (ICP-MS) particle tracking analysis (PTA) scanning electron microscopy (SEM) small-angle X-ray scattering (SAXS) transmission electron microscopy (TEM)
Shape	atomic-force microscopy (AFM) scanning electron microscopy (SEM) transmission electron microscopy (TEM)
Surface area	Brunauer–Emmett–Teller (BET) method
“Surface” chemistry	Raman spectroscopy secondary-ion mass spectrometry (SIMS) X-ray photoelectron spectroscopy (XPS)
Chemistry of the “bulk” sample	energy-dispersive X-ray spectroscopy (EDX) inductively coupled plasma mass spectrometry (ICP-MS) nuclear magnetic resonance (NMR) spectroscopy
Crystallinity	selected area electron diffraction (SAED) X-ray diffraction (XRD)
Electrokinetic potential in suspensions	electrophoretic mobility

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Nanotechnologies — Vocabulary —

Part 6: Nano-object characterization

1 Scope

This document defines terms related to the characterization of nano-objects in the field of nanotechnologies.

It is intended to facilitate communication between organizations and individuals in research, industry and other interested parties and those who interact with them.

2 Normative references

There are no normative references in this document.

3 Terms and definitions (General terms)

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 http://www.electropedia.org/

3.1
nanoscale
length range approximately from 1 nm to 100 nm

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

[SOURCE: ISO/TS 80004-1:2015, 2.1]

3.2
nano-object
discrete piece of material with one, two or three external dimensions in the *nanoscale* (3.1)

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

[SOURCE: ISO/TS 80004-1:2015, 2.5]

3.3
nanoparticle
nano-object (3.2) with all external dimensions in the *nanoscale* (3.1) where the lengths of the longest and the shortest axes of the nano-object do not differ significantly

Note 1 to entry: If the dimensions differ significantly (typically by more than three times), terms such as *nanofibre* (3.6) or *nanoplate* (3.4) may be preferred to the term "nanoparticle".

[SOURCE: ISO/TS 80004-2:2015, 4.4]

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3.4
nanoplate
nano-object (3.2) with one external dimension in the *nanoscale* (3.1) and the other two external dimensions significantly larger

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

Note 2 to entry: See 3.3, Note 1 to entry.

[SOURCE: ISO/TS 80004-2:2015, 4.6]

3.5
nanorod
solid *nanofibre* (3.6)

[SOURCE: ISO/TS 80004-2:2015, 4.7]

3.6
nanofibre
nano-object (3.2) with two external dimensions in the *nanoscale* (3.1) and the third dimension significantly larger

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

Note 2 to entry: The terms “nanofibril” and “nanofilament” can also be used.

Note 3 to entry: See 3.3, Note 1 to entry.

[SOURCE: ISO/TS 80004-2:2015, 4.5]

3.7
nanotube
hollow *nanofibre* (3.6)

[SOURCE: ISO/TS 80004-2:2015, 4.8]

3.8
quantum dot
nanoparticle (3.3) or region which exhibits quantum confinement in all three spatial directions

[SOURCE: ISO/TS 80004-12:2016, 4.1, modified — Note 1 to entry has been deleted.]

3.9
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: A particle can move as a unit.

Note 3 to entry: This general particle definition applies to *nano-objects* (3.2).

[SOURCE: ISO/TS 80004-2:2015, 3.1]

3.10
agglomerate
collection of weakly or medium strongly bound *particles* (3.9) 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”.

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[SOURCE: ISO/TS 80004-2:2015, 3.4]

3.11
aggregate
particle (3.9) 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, or otherwise combined former primary particles.

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

[SOURCE: ISO/TS 80004-2:2015, 3.5]

3.12
aerosol
system of solid and/or liquid *particles* (3.9) suspended in gas

[SOURCE: ISO 15900:2020, 3.1]

3.13
suspension
heterogeneous mixture of materials comprising a liquid and a finely dispersed solid material

[SOURCE: ISO 4618:2014, 2.246]

3.14
dispersion
multi-phase system in which discontinuities of any state (solid, liquid or gas: discontinuous phase) are distributed in a continuous phase of a different composition or state

Note 1 to entry: This term also refers to the act or process of producing a dispersion; in this context the term "dispersion process" should be used.

Note 2 to entry: If solid *particles* (3.9) are distributed in a liquid, the dispersion is referred to as a *suspension* (3.13). If the dispersion consists of two or more immiscible liquid phases, it is termed an "emulsion". A suspoemulsion consists of both solid and liquid phases distributed in a continuous liquid phase.

[SOURCE: ISO/TR 13097:2013, 2.5, modified — In the definition, "in general, microscopic" has been deleted and "distributed" has replaced "dispersed". Notes 1 and 2 to entry have replaced the original Note 1 to entry.]

4 Terms related to size and shape measurement

4.1 Terms related to measurands for size and shape

4.1.1
particle size
linear dimension of a *particle* (3.9) determined by a specified measurement method and under specified measurement conditions

Note 1 to entry: Different methods of analysis are based on the measurement of different physical properties. Independent of the particle property actually measured, the particle size can be reported as a linear dimension, e.g. as the equivalent spherical diameter.

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