PD CEN ISO/TS 80004-6:2015

BSI Standards Publication

Nanotechnologies — Vocabulary

Part 6: Nano-object characterization

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee NTI/1, Nanotechnologies.

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

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Nanotechnologien - Fachwörterverzeichnis - Teil 6: Charakterisierung von Nanoobjekten (ISO/TS 80004-6:2013)

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Foreword

The text of ISO/TS 80004-6:2013 has been prepared by Technical Committee ISO/TC 229 “Nanotechnologies” of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TS 80004-6:2015 by Technical Committee CEN/TC 352 “Nanotechnologies” the secretariat of which is held by AFNOR.

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Foreword

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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. www.iso.org/directives

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ISO/TS 80004-6 was prepared jointly by Technical Committee ISO/TC 229, *Nanotechnologies* and Technical Committee IEC/TC 113, *Nanotechnology standardization for electrical and electronic products and systems*. The draft was circulated for voting to the national bodies of both ISO and IEC.

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 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 2: Nano-objects: Nanoparticle, nanofibre and nanoplate*[1)]

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

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

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

1) Revision of ISO/TS 27687:2008, *Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate*.

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— *Part 12: Quantum phenomena in nanotechnology*

Graphene and other two dimensional materials will form the subject of a future Part 13.

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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 2: General terms

— Clause 3: Terms related to size and shape measurement

— Clause 4: Terms related to chemical analysis

— Clause 5: Terms related to measurement of other properties

These headings are intended as guide only, as some techniques can determine more than one property. Subclause 3.1 lists the overarching measurands that apply to the rest of Clause 3. 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, for example placing the nano-objects on a surface or placing it 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 main current techniques for nano-object characterization.

Table 1 — Alphabetical list of main current techniques for nano-object characterization

Property	Current main techniques
Size	atomic force microscopy (AFM), centrifugal liquid sedimentation (CLS), differential mobility analysing system (DMAS), dynamic light scattering (DLS), scanning electron microscopy (SEM), particle tracking analysis (PTA), 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	secondary ion mass spectrometry (SIMS), X-ray photoelectron spectroscopy (XPS)
Chemistry of the ‘bulk’ sample	inductively coupled plasma mass spectrometry (ICP-MS), nuclear magnetic resonance spectroscopy (NMR)
Charge in suspensions	zeta potential

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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Nanotechnologies — Vocabulary —

Part 6: Nano-object characterization

1 Scope

This Technical Specification lists terms and definitions relevant to the characterization of nano-objects.

2 General terms

2.1
nanoscale
size range from approximately 1 nm to 100 nm

Note 1 to entry: Properties that are not extrapolations from a larger size will typically, but not exclusively, be exhibited in this size range. For such properties the size limits are considered approximate.

Note 2 to entry: The lower limit in this definition (approximately 1 nm) is introduced to avoid single and small groups of atoms from being designated as *nano-objects* (2.2) or elements of nanostructures, which might be implied by the absence of a lower limit.

[SOURCE: ISO/TS 80004-1:2010, definition 2.1]

2.2
nano-object
material with one, two or three external dimensions in the *nanoscale* (2.1)

Note 1 to entry: Generic term for all discrete nanoscale objects.

[SOURCE: ISO/TS 80004-1:2010, definition 2.5]

2.3
nanoparticle
nano-object (2.2) with all three external dimensions in the *nanoscale* (2.1)

Note 1 to entry: If the lengths of the longest to the shortest axes of the nano-object differ significantly (typically by more than three times), the terms *nanofibre* (2.6) or *nanoplate* (2.4) are intended to be used instead of the term nanoparticle.

[SOURCE: ISO/TS 27687:2008, definition 4.1]

2.4
nanoplate
nano-object (2.2) with one external dimension in the *nanoscale* (2.1) and the two other external dimensions significantly larger

Note 1 to entry: The smallest external dimension is the thickness of the nanoplate.

Note 2 to entry: The two significantly larger dimensions are considered to differ from the nanoscale dimension by more than three times.

Note 3 to entry: The larger external dimensions are not necessarily in the nanoscale.

[SOURCE: ISO/TS 27687:2008, definition 4.2]

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2.5
nanorod
solid *nanofibre* (2.6)

[SOURCE: ISO/TS 27687:2008, definition 4.5]

2.6
nanofibre
nano-object (2.2) with two similar external dimensions in the *nanoscale* (2.1) and the third dimension significantly larger

Note 1 to entry: A nanofibre can be flexible or rigid.

Note 2 to entry: The two similar external dimensions are considered to differ in size by less than three times and the significantly larger external dimension is considered to differ from the other two by more than three times.

Note 3 to entry: The largest external dimension is not necessarily in the nanoscale.

[SOURCE: ISO/TS 27687:2008, definition 4.3]

2.7
nanotube
hollow *nanofibre* (2.6)

[SOURCE: ISO/TS 27687:2008, definition 4.4]

2.8
quantum dot
crystalline *nanoparticle* (2.3) that exhibits size-dependent properties due to quantum confinement effects on the electronic states

[SOURCE: ISO/TS 27687:2008, definition 4.7]

2.9
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* (2.2).

[SOURCE: ISO 14644-6:2007, definition 2.102 and ISO/TS 27687:2008, definition 3.1]

2.10
agglomerate
collection of weakly bound *particles* (2.9) or *aggregates* (2.11) or mixtures of the two 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.

[SOURCE: ISO/TS 27687:2008, definition 3.2]

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2.11
aggregate
particle (2.9) comprising strongly bonded or fused particles where the resulting external surface area may be significantly smaller than the sum of calculated surface areas of the individual components

Note 1 to entry: The forces holding an aggregate together are strong forces, for example covalent 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/TS 27687:2008, definition 3.3]

2.12
aerosol
system of solid or liquid *particles* (2.9) suspended in gas

[SOURCE: ISO 15900:2009, definition 2.1]

2.13
suspension
heterogeneous mixture of materials comprising a liquid and a finely dispersed solid material

[SOURCE: ISO 4618:—, definition 2.243]

3 Terms related to size and shape measurement

3.1 Terms related to measurands for size and shape

3.1.1
particle size
linear dimension of a *particle* (2.9) determined by a specified measurement method and under specified measurement conditions

[SOURCE: ISO 26824:2013, definition 1.5]

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.

3.1.2
particle size distribution
distribution of *particles* (2.9) as a function of *particle size* (3.1.1)

[SOURCE: ISO 14644-1:1999, definition 2.2.4, modified]

Note 1 to entry: Particle size distribution may be expressed as cumulative distribution or a distribution density (distribution of the fraction of material in a size class, divided by the width of that class).

3.1.3
particle shape
external geometric form of a *particle* (2.9)

[SOURCE: ISO 3252:1999]

3.1.4
aspect ratio
ratio of length of a *particle* (2.9) to its width

[SOURCE: ISO 14966:2002, definition 2.8]

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