
**Nanotechnologies — Vocabulary —
Part 6:
Nano-object characterization**

*Nanotechnologies — Vocabulaire —
Partie 6: Caractérisation d'un nano-objet*

iTeh Standards
(<https://standards.itih.ai>)
Document Preview

ISO/TS 80004-6:2013

<https://standards.itih.ai/standards/iso/6a15e2cd-46b1-4f55-ac75-77c4da047281/iso-ts-80004-6-2013>

Withdrawing

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

ISO TS 80004-6:2013
<https://standards.iteh.ai/Catalogue/standards/iso/6a15e2cd-46b1-4f55-ac75-77c4da047281/iso-ts-80004-6-2013>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2013

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

	Page
Foreword	iv
Introduction	vi
1 Scope	1
2 General terms	1
3 Terms related to size and shape measurement	3
3.1 Terms related to measurands for size and shape.....	3
3.2 Terms related to scattering techniques.....	4
3.3 Terms related to aerosol characterization.....	5
3.4 Terms related to separation techniques.....	6
3.5 Terms related to microscopy.....	7
3.6 Terms related to surface area measurement.....	10
4 Terms related to chemical analysis	11
5 Terms related to measurement of other properties	15
5.1 Terms related to mass measurement.....	15
5.2 Terms related to crystallinity measurement.....	16
5.3 Terms related to charge measurement in suspensions.....	16
Annex A (informative) Index	18
Bibliography	23

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

ISO/TS 80004-6:2013

<https://standards.iteh.ai/standards/iso/6a15e2cd-46b1-4f55-ac75-77c4da047281/iso-ts-80004-6-2013>

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. 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. 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

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 nanoplate¹⁾
- 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*.

— *Part 12: Quantum phenomena in nanotechnology*

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

Witholdam
iTeh Standards
(<https://standards.itih.ai>)
Document Preview
ISO TS 80004-6:2013
<https://standards.itih.ai/standards/iso/6a15e2cd-46b1-4f55-ac75-77c4da047281/iso-ts-80004-6-2013>

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. 6-2013

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.

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]

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]

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]

3.1.5

equivalent diameter

diameter of a sphere that produces a response by a given particle-sizing method, that is equivalent to the response produced by the *particle* (2.9) being measured

Note 1 to entry: The physical property to which the equivalent diameter refers is indicated using a suitable subscript (see ISO 9276-1:1998).

Note 2 to entry: For discrete-particle-counting, light-scattering instruments, an equivalent optical diameter is used.

Note 3 to entry: Other material constants like density of the particle are used for the calculation of the equivalent diameter like Stokes diameter or sedimentation equivalent diameter. The material constants, used for the calculation, should be reported additionally.

Note 4 to entry: For inertial instruments, the aerodynamic diameter is used. Aerodynamic diameter is the diameter of a sphere of density 1 000 kg m⁻³ that has the same settling velocity as the irregular particle.

[SOURCE: ISO/TS 27687:2008, A.3.3, modified]

3.2 Terms related to scattering techniques

3.2.1

radius of gyration

measure of the distribution of mass about a chosen axis, given as the square root of the moment of inertia about that axis divided by the mass

[SOURCE: ISO 14695:2003, definition 3.4]

Note 1 to entry: For *nano-object* (2.2) characterization, physical methods that measure radius of gyration to determine *particle size* (3.1.1) include static light scattering, *small angle neutron scattering* (3.2.2) and *small angle X-ray scattering* (3.2.4).

3.2.2

small angle neutron scattering

SANS

method in which a beam of neutrons is scattered from a sample and the scattered neutron intensity is measured for small angle deflection

Note 1 to entry: The scattering angle is usually between 0,5° and 10° in order to study the structure of a material on the length scale of 1 nm to 100 nm. The method provides information on the sizes of the *particles* (2.9) and to a limited extent the shapes of the particles dispersed in homogeneous medium.

3.2.3

neutron diffraction

application of elastic neutron scattering for the determination of the atomic or magnetic structure of matter

Note 1 to entry: The neutrons emerging from the experiment have approximately the same energy as the incident neutrons. A diffraction pattern is formed that provides information on the structure of the material.

3.2.4

small angle X-ray scattering

SAXS

method in which the elastically scattered intensity of X-rays is measured for small-angle deflections

Note 1 to entry: The angular scattering is usually measured within the range 0,1° to 10°. This provides structural information on macromolecules as well as periodicity on length scales typically larger than 5 nm and less than 200 nm for ordered or partially ordered systems.

[SOURCE: ISO 18115-1, definition 4.18]

3.2.5**light scattering**

change in propagation of light at the interface of two media having different optical properties

[SOURCE: ISO 13320:2009, definition 3.1.17]

3.2.6**hydrodynamic diameter**

equivalent diameter (3.1.5) of a *particle* (2.9) in a liquid having the same diffusion coefficient as the real particle in that liquid

3.2.7**dynamic light scattering****DLS****photon correlation spectroscopy****PCS****quasi-elastic light scattering****QELS**

method in which *particles* (2.9) undergoing Brownian motion in a liquid *suspension* (2.13) are illuminated by a laser and the change in intensity of the scattered light is used to determine *particle size* (3.1.1)

Note 1 to entry: Analysis of the time-dependent intensity of the scattered light can yield the translational diffusion coefficient and hence the particle size as the *hydrodynamic diameter* (3.2.6) via the Stokes–Einstein relationship.

Note 2 to entry: The analysis is applicable to *nanoparticles* (2.3) as the size of particles detected is typically in the range 1 nm to 6000 nm. The upper limit is due to limited Brownian motion and sedimentation.

3.2.8**nanoparticle tracking analysis****NTA****particle tracking analysis****PTA**

method where *particles* (2.9) undergoing Brownian motion in a liquid *suspension* (2.13) are illuminated by a laser and the change in position of individual particles is used to determine *particle size* (3.1.1)

Note 1 to entry: Analysis of the time-dependent position of individual particles by means of scattered light can yield the translational diffusion coefficient and hence the particle size as the *hydrodynamic diameter* (3.2.6) using the Stokes–Einstein relationship

Note 2 to entry: The analysis is applicable to *nanoparticles* (2.3) as the size of particles detected is typically in the range 10 nm to 2000 nm. The lower limit requires particles with high refractive index and the upper limit is due to limited Brownian motion and sedimentation.

3.3 Terms related to aerosol characterization**3.3.1****condensation particle counter****CPC**

instrument that measures the *particle* (2.9) number concentration of an *aerosol* (2.12)

Note 1 to entry: The sizes of particles detected are usually smaller than several hundred nanometres and larger than a few nanometres.

Note 2 to entry: A CPC is one possible detector suitable for use with a *differential electrical mobility classifier* (DEMC) (3.3.2).

Note 3 to entry: In some cases, a condensation particle counter may be called a condensation nucleus counter (CNC).

[SOURCE: ISO 15900:2009, definition 2.5]