SLOVENSKI STANDARD
SIST-TS CEN/TS 17010:2017

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Nanotehnologija - Navodilo glede merjenih veličin za ugotavljanje lastnosti nanodelcev in materialov, ki jih vsebujejo

Nanotechnologies - Guidance on measurands for characterising nano-objects and materials that contain them

Nanotechnologien - Leitfaden über Messgrößen zur Charakterisierung von Nanoobjekten und von Werkstoffen, die welche enthalten

Nanotechnologies - Guide sur les mesurandes pour la caractérisation de nano-objects et des matériaux les contenant

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Nanotechnologies - Guidance on measurands for characterising nano-objects and materials that contain them

Nanotechnologies - Guide sur les mesurandes pour la caractérisation de nano-objects et des matériaux les contenant

Nanotechnologien - Leitfaden über Messgrößen zur Charakterisierung von Nanoobjekten und von Werkstoffen, die welche enthalten

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Contents

Page

European foreword

This document (CEN/TS 17010:2016) has been prepared by Technical Committee CEN/TC 352 “Nanotechnologies”, the secretariat of which is held by AFNOR.

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Introduction

The term “nano-object” applies to materials having one, two or three external dimensions in the nanoscale (therefore in the range of approximately 1 to 100 nanometres). Specific properties of nano-objects are usually exhibited in this size range, even if they do not disappear abruptly beyond these limits. Nano-objects, either natural or manufactured, can then be found in the form of nanoplates (one dimension in the nanoscale), nanofibres (two dimensions, or the diameter, in the nanoscale), and nanoparticles (three dimensions in the nanoscale). Nano-objects exhibit higher specific surface areas than larger objects. They are particularly prone to aggregation and agglomeration phenomena due to attractive interactions during their life cycle.

There is increasing use of nano-objects in research and development, industry and commercial applications. Characterization of nano-objects, and their agglomerates and aggregates (sometimes referred to as NOAA) plays an essential role in basic and applied research, through process and product quality control and commercialization to health and environmental protection. Characterization of nano-objects is key to determine their properties, performance and life-time. The methods available for characterization of larger scale materials are often difficult to apply to nano-objects, sometimes due to restrictions of the test systems (e.g. low sensitivity, inadequate resolution of equipment). This has resulted in new techniques and adapting old methods.

One definition of “measurand” used in many ISO standards is the “quantity intended to be measured”. In nanotechnologies measurement and characterization this “intended quantity” could be size, shape, chemical composition, surface charge, etc. However, in reality, an instrument does not always directly measure this fundamental characteristic but measures something else, which is ultimately related to the intended quantity.

This Technical Specification (TS) describes and defines the measurands, both the overarching intended measurands and those actually measured by the instruments, in order to elucidate which measurements can be compared with each other and under which conditions and assumptions. The Technical Specification is split into ten main clauses covering:

— Size and shape (see Clause 6);

— Chemical analysis (see Clause 7);

— Mass and density (see Clause 8);

— Charge (see Clause 9);

— Crystallinity (see Clause 10);

— Optical (see Clause 11);

— Electrical and electronic (see Clause 12);

— Magnetic (see Clause 13);

— Thermal (see Clause 14);

— Other performance related measurands (see Clause 15).

1 Scope

This Technical Specification provides guidelines for the identification of measurands to characterize nano-objects, and their agglomerates and aggregates and to assess specific properties relevant to the performance of materials that contain them. It provides guidance for relevant and reliable measurement.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 481:1993, *Workplace atmospheres - Size fraction definitions for measurement of airborne particles*

EN ISO 3219:1994, *Plastics - Polymers/resins in the liquid state or as emulsions or dispersions - Determination of viscosity using a rotational viscometer with defined shear rate (ISO 3219:1993)*

EN ISO 6892-1:2016, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2016)*

CEN ISO/TS 12025:2015, *Nanomaterials - Quantification of nano-object release from powders by generation of aerosols (ISO/TS 12025:2012)*

EN ISO 14577-1:2015, *Metallic materials - Instrumented indentation test for hardness and materials parameters - Part 1: Test method (ISO 14577-1:2015)*

EN ISO 14577-2:2015, *Metallic materials - Instrumented indentation test for hardness and materials parameters - Part 2: Verification and calibration of testing machines (ISO 14577-2:2015)*

EN ISO 14577-3:2015, *Metallic materials - Instrumented indentation test for hardness and materials parameters - Part 3: Calibration of reference blocks (ISO 14577-3:2015)*

EN ISO 14577-4:2007, *Metallic materials - Instrumented indentation test for hardness and materials parameters - Part 4: Test method for metallic and non-metallic coatings (ISO 14577-4:2007)*

EN 15051-1:2013, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 1: Requirements and choice of test methods*

EN 15051-2:2013, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 2: Rotating drum method*

EN 15051-3:2013, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 3: Continuous drop method*

CEN ISO/TS 80004-1:2015, *Nanotechnologies - Vocabulary - Part 1: Core terms (ISO/TS 80004-1:2015)*

ISO/TS 80004-2:2015, *Nanotechnologies - Vocabulary - Part 2: Nano-objects*

CEN ISO/TS 80004-6:2015, *Nanotechnologies - Vocabulary - Part 6: Nano-object characterization (ISO/TS 80004-6:2013)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CEN ISO/TS 80004-1:2015, ISO/TS 80004-2:2015 and CEN ISO/TS 80004-6:2015 and the following apply.

3.1 General core terms

3.1.1
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* (3.1.2) or elements of nanostructures, which might be implied by the absence of a lower limit.

[SOURCE: CEN ISO/TS 80004-6:2015, 2.1]

3.1.2
nano-object
material with one, two or three external dimensions in the *nanoscale* (3.1.1)

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

[SOURCE: CEN ISO/TS 80004-6:2015, 2.2]

3.1.3

agglomerate
collection of weakly bound *particles* (CEN ISO/TS 80004-6:2015, 2.9) or *aggregates* (3.1.4) 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: CEN ISO/TS 80004-6:2015, 2.10]

3.1.4
aggregate
particle (CEN ISO/TS 80004-6:2015, 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: CEN ISO/TS 80004-6:2015, 2.11]

3.2 Measurand terms

3.2.1
measurand
quantity intended to be measured

Note 1 to entry: The specification of a measurand requires knowledge of the kind of quantity, description of the state of the phenomenon, body, or substance carrying the quantity, including any relevant component, and the chemical entities involved.

Note 2 to entry: In the second edition of the VIM and in IEC 60050–300:2001, the measurand is defined as the "particular quantity subject to measurement".

Note 3 to entry: The measurement, including the measuring system and the conditions under which the measurement is carried out, might change the phenomenon, body, or substance such that the quantity being measured may differ from the measurand as defined. In this case, adequate correction is necessary.

EXAMPLE 1 The potential difference between the terminals of a battery may decrease when using a voltmeter with a significant internal conductance to perform the measurement. The open-circuit potential difference can be calculated from the internal resistances of the battery and the voltmeter.

EXAMPLE 2 The length of a steel rod in equilibrium with the ambient Celsius temperature of 23 °C will be different from the length at the specified temperature of 20 °C, which is the measurand. In this case, a correction is necessary.

Note 4 to entry: In chemistry, "analyte", or the name of a substance or compound, are terms sometimes used for "measurand". This usage is erroneous because these terms do not refer to quantities.

[SOURCE: ISO/IEC GUIDE 99:2007, 2.3]

3.2.2
particle size
linear dimension of a *particle* (CEN ISO/TS 80004-6:2015, 2.9) 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.

[SOURCE: CEN ISO/TS 80004-6:2015, 3.1.1]

3.2.3
particle size distribution
distribution of *particles* (CEN ISO/TS 80004-6:2015, 2.9) as a function of *particle size* (3.2.2)

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).

[SOURCE: CEN ISO/TS 80004-6:2015, 3.1.2]

3.2.4
particle shape
external geometric form of a *particle* (CEN ISO/TS 80004-6:2015, 2.9)

[SOURCE: CEN ISO/TS 80004-6:2015, 3.1.3]

3.2.5
aspect ratio
ratio of length of a *particle* (CEN ISO/TS 80004-6:2015, 2.9) to its width

[SOURCE: CEN ISO/TS 80004-6:2015, 3.1.4]

3.2.6
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 (see CEN ISO/TS 80004-6:2015, 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: CEN ISO/TS 80004-6:2015, 3.1.5]

3.2.7
light scattering
change in propagation of light at the interface of two media having different optical properties

[SOURCE: CEN ISO/TS 80004-6:2015, 3.2.5]

3.2.8
hydrodynamic diameter
equivalent diameter (3.2.6) of a *particle* (CEN ISO/TS 80004-6:2015, 2.9) in a liquid having the same diffusion coefficient as the real particle in that liquid

[SOURCE: CEN ISO/TS 80004-6:2015, 3.2.6]

3.2.9
aerodynamic diameter
diameter of a sphere of density 1 g/cm^3 with the same terminal velocity due to gravitational force in calm air as the particle, under prevailing conditions of temperature, pressure and relative humidity

Note 1 to entry: Adapted from ISO 7708:1995, 2.2.

[SOURCE: EN ISO 23210:2009, 3.1.1]

3.2.10
thermodynamic diameter
diameter of a sphere with the same diffusion coefficient as the particle under prevailing condition of temperature and pressure

Note 1 to entry: The thermodynamic diameter of a particle depends on its size and shape, but not its density.

[SOURCE: EN ISO 13138:2012, 3.2, modified]

3.2.11
(electrical) mobility (equivalent) diameter
diameter of a sphere carrying a single elementary charge with the same drift speed in an electric field as the particle under prevailing condition of temperature and pressure

Note 1 to entry: The mobility diameter of a particle depends on its size, shape and electric charge level (which depends on the charging process involved its capacitance, i.e. its capacity to become electrically charged by bipolar air ions), but not of its density.

[SOURCE: prEN 16966:2016]

3.2.12
mass specific surface area
absolute surface area of the sample divided by sample mass

Note 1 to entry: Mass specific surface area has units of m^2/kg.

[SOURCE: CEN ISO/TS 80004-6:2015, 3.6.1]

3.2.13
volume specific surface area
absolute surface area of the sample divided by sample volume

Note 1 to entry: Volume specific surface area has units of m^{-1}.

[SOURCE: CEN ISO/TS 80004-6:2015, 3.6.2]

3.2.14
photoluminescence
luminescence (see CEN ISO/TS 80004-6:2015, 4.2) caused by absorption of optical radiation

[SOURCE: CEN ISO/TS 80004-6:2015, 4.3]

3.2.15
Raman effect
emitted radiation, associated with molecules illuminated with monochromatic radiation, characterized by an energy loss or gain arising from rotational or vibrational excitations

[SOURCE: CEN ISO/TS 80004-6:2015, 4.9]

3.2.16
lattice parameters
linear and angular dimensions of the crystallographic unit cell

Note 1 to entry: Most engineering materials have either cubic or hexagonal crystal structures. Hence the lattice parameters usually only refer to the lengths of the unit cell edges.

[SOURCE: CEN ISO/TS 21432:2005, definition 3.18]

3.2.17
scattering angle
angle between the direction of the incident particle or photon and the direction that the particle or photon is travelling after scattering

[SOURCE: ISO 18115-1:2013, definition 4.18]

3.2.18
electrokinetic potential
zeta potential
difference in electric potential between that at the slipping plane and that of the bulk liquid