SLOVENSKI STANDARD
kSIST-TS FprCEN ISO/TS 12025:2020

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Nanomateriali - Kvantifikacija sproščanja nanoobjektov iz prahu s proizvodnjo aerosola (ISO/PRF TS 12025:2020)

Nanomaterials - Quantification of nano-object release from powders by generation of aerosols (ISO/PRF TS 12025:2020)

Nanomaterialien - Quantifizierung der Freisetzung von Nanoobjekten aus Pulvern durch Aerosolerzeugung (ISO/PRF TS 12025:2020)

Nanomatériaux - Quantification de la libération de nano-objets par les poudres par production d'aérosols (ISO/PRF TS 12025:2020)

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Second edition

Nanomaterials — Quantification of nano-object release from powders by generation of aerosols

Nanomatériaux — Quantification de la libération de nano-objets par les poudres par production d'aérosols

Member bodies are requested to consult relevant national interests in IEC/TC 113 before casting their ballot to the e-Balloting application.

PROOF/ÉPREUVE

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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 (see www. iso. org/directives).

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This document was prepared jointly by Technical Committee ISO/TC 229, *Nanotechnologies*, and Technical Committee IEC/TC 113, Nanotechnology for electrotechnical products and systems, in collaboration 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 12025:2012), which has been technically revised.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Industrial powders when subjected to external energy or stress from handling and air flow will release particles entrained in the surrounding air to form aerosols. Aerosols of nano-objects are more dynamic than micrometre sized particles because of greater sensitivity to physical effects such as Brownian diffusion. Porosity and cohesion of the powder can be much higher than those containing larger particles with more resistance to flow and lower volume-specific surface area. Nano-objects in powdered nanostructured materials can dominate relevant properties of the bulk material by particle-particle interactions that form clusters such as agglomerates.

Aerosol release characterization consists of three main stages: generation, transport and measurement. In general, to reduce transport losses and aerosol agglomeration, the distance between generation and measurement should be minimized. Although there are potentially many different approaches[35], the generation of an aerosol is usually physically modelled on different representative scenarios (e.g. to simulate typical manual or machine powder handling processes or worst case highly energetic dispersion).

This document is only applicable for measuring the release of nano-objects from powders. This allows comparisons of the nano-object release from different powders using the same generation and measurement system. The choice of the measurement method must take into account the characteristics (e.g. time-related dependence) of the generation system and the potential for losses and agglomeration during the transport and entry into the measuring instrumentation. Therefore, this document provides a summary of the generation and measurement methods currently available to assist material scientists and engineers in comparing the nano-object release from different powders.

The quantification of the release of nano-objects from powders described in this document cannot be used as a substitute for dustiness testing or for a health-related risk assessment.

Nanomaterials — Quantification of nano-object release from powders by generation of aerosols

WARNING — The execution of the provisions of this document should be entrusted only to appropriately qualified and experienced people, for whose use it has been produced.

1 Scope

This document describes methods for the quantification of nano-object release from powders as a result of treatment, ranging from handling to high energy dispersion, by measuring aerosols liberated after a defined aerosolization procedure. Particle number concentration and size distribution of the aerosol are measured and the mass concentration is derived. This document provides information on factors to be considered when selecting among the available methods for powder sampling and treatment procedures and specifies minimum requirements for test sample preparation, test protocol development, measuring particle release and reporting data. In order to characterize the full size range of particles generated, the measurement of nano-objects as well as agglomerates and aggregates is recommended in this document.

This document does not include the characterization of particle sizes within the powder. Tribological methods are excluded where direct mechanical friction is applied to grind or abrade the material.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 80004-1:2015, *Nanotechnologies — Vocabulary — Part 1: Core terms*

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

3 Terms and definitions

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

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 General terms

3.1.1
release from powder
transfer of material from a powder to a liquid or gas as a consequence of a disturbance

3.1.2
nano-object number release
n
total number of *nano-objects* (3.2.9), released from a sample as a consequence of a disturbance

3.1.3
nano-object release rate
n_t
total number of *nano-objects* (3.2.9), released per second as a consequence of a disturbance

3.1.4
mass specific nano-object number release
n_m
nano-object number release (3.1.2), divided by the mass of the sample before a disturbance

3.1.5
mass loss specific nano-object number release
$n_{\Delta m}$
nano-object number release (3.1.2), divided by the mass difference of the sample before and after a disturbance

3.1.6
nano-object aerosol number concentration
c_n
number of *nano-objects* (3.2.9) per aerosol volume unit in the sample treatment zone

3.1.7
aerosol volume flow rate
V_t
volume flow rate through the sample treatment zone

3.2 Terms related to particle properties and measurement

3.2.1
aerosol
system of solid or liquid particles suspended in gas

[SOURCE: ISO 15900:2009, 2.1]

3.2.2
equivalent spherical diameter
diameter of a sphere having the same physical properties as the particle in the measurement

Note 1 to entry: Physical properties are, for instance, the same settling velocity or electrolyte solution displacing volume or projection area under a microscope.

Note 2 to entry: The physical property to which the equivalent diameter refers shall be indicated using a suitable subscript, e.g. x_s for equivalent surface area diameter or x_v for equivalent volume diameter.

[SOURCE: ISO/TS 80004-2:2015, A.2.3]

3.2.3
particle size distribution
PSD
cumulative distribution or distribution density of a quantity of particle sizes, represented by *equivalent spherical diameters* (3.2.2) or other linear dimensions

Note 1 to entry: Quantity measures and types of distributions are defined in ISO 9276-1:1998[3].

3.2.4
PM2,5
particulate matter smaller than 2,5 µm
mass concentration of fine particulate matter having an aerodynamic diameter less than or equal to a nominal 2,5 micrometres ($PM_{2,5}$)

Note 1 to entry: See Appendix J in Reference [47].

3.2.5
PM10
particulate matter smaller than 10 µm
mass concentration of fine particulate matter having an aerodynamic diameter less than or equal to a nominal 10 micrometres (PM_{10})

Note 1 to entry: See Appendix J in Reference [47].

Note 2 to entry: PM10 is used for the thoracic fraction as explained in EN 481:1993[15].

3.2.6
condensation particle counter
CPC
instrument that measures the particle number concentration of an *aerosol* (3.2.1) using a condensation effect to increase the size of the aerosolized particles

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 for use with a *differential electrical mobility classifier* (3.2.7).

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

[SOURCE: ISO 15900:2009, 2.5, modified — "using a condensation effect to increase the size of the aerosolized particles" as been added to the definition.]

3.2.7
differential electrical mobility classifier
DEMC
classifier that is able to select *aerosol* (3.2.1) particles according to their electrical mobility and pass them to its exit

Note 1 to entry: A DEMC classifies aerosol particles by balancing the electrical force on each particle with its aerodynamic drag force in an electrical field. Classified particles are in a narrow range of electrical mobility determined by the operating conditions and physical dimensions of the DEMC, while they can have different sizes due to difference in the number of charges that they have.

[SOURCE: ISO 15900:2009, 2.7]

3.2.8
differential mobility analysing system
DMAS
system to measure the size distribution of sub-micrometre *aerosol* (3.2.1) particles consisting of a *differential electrical mobility classifier* (3.2.7), flow meters, a particle detector, interconnecting plumbing, a computer and suitable software

[SOURCE: ISO 15900:2009, 2.8]

3.2.9
nano-object
material with one, two or three external dimensions in the *nanoscale* (3.2.10)

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

[SOURCE: ISO/TS 80004-2:2015, 2.2, modified — "discrete piece of" has been deleted from the start of the definition and the Note 1 to entry has been replaced.]

3.2.10
nanoscale
size range approximately from 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* (3.2.9) or elements of nanostructures, which could be implied by the absence of a lower limit.

[SOURCE: ISO/TS 80004-2:2015, 2.1, modified — Note 1 to entry has been replaced and Note 2 to entry has been added.]

3.2.11
agglomerate
collection of loosely bound particles or *aggregates* (3.2.12) or mixtures of the two held together by weak forces where the resulting external surface area is similar to the sum of the surface areas of the individual components

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

Note 2 to entry: Agglomerates are secondary particles and the original source particles are primary particles.

[SOURCE: ISO/TS 80004-2:2015, 3.4, modified — "loosely bound particles or aggregates or mixtures of the two" has replaced "weakly or medium strongly bound particles" the notes to entry have been reworded.]

3.2.12
aggregate
particle comprising strongly bonded or fused particles held together by strong forces where the resulting external surface area is significantly smaller than the sum of calculated surface areas of the individual components

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

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

[SOURCE: ISO/TS 80004-2:2015, 3.5, modified — "held together by strong forces" has been added to the definition and the notes to entry have been reworded.]

3.2.13
dustiness
propensity of materials to produce airborne dust during handling

Note 1 to entry: For the purpose of this document, dustiness is derived from the amount of dust emitted during a standard test procedure.

Note 2 to entry: Dustiness is not an intrinsic property as it depends on how it is measured.

[SOURCE: EN 1540:2011, 2.5.1]

3.2.14
inhalable fraction
mass fraction of total airborne particles which is inhaled through the nose and mouth

Note 1 to entry: The inhalable fraction is specified in EN 481:1993[15].

[SOURCE: EN 1540:2011, 2.3.1.1]

3.2.15
thoracic fraction
mass fraction of inhaled particles penetrating beyond the larynx

Note 1 to entry: The thoracic fraction is specified in EN 481:1993[15].

[SOURCE: EN 1540:2011, 2.3.1.2]

