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

Nanomatériaux - Quantification de la libération de nano-objets par les poudres par production d'aérosols (ISO/TS 12025:2012)

Nanomaterialien - Quantifizierung der Freisetzung von Nanoobjekten aus Pulvern durch Aerosolerzeugung (ISO/TS 12025:2012)

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Foreword

The text of ISO/TS 12025:2012 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 12025:2015 by Technical Committee CEN/TC 352 “Nanotechnologies” the secretariat of which is held by AFNOR.

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Endorsement notice

The text of ISO/TS 12025:2012 has been approved by CEN as CEN ISO/TS 12025:2015 without any modification.

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Introduction

The emissions or release of nano-objects into the surrounding air from powdered nanostructured materials resulting from handling is an important consideration in the design and operation of many industrial processes. Released nano-objects may affect human health and the environment, depending on the nature and quanitity of the nanomaterial. It is therefore important to obtain data about the propensity of nanomaterials to release nano-objects, thereby allowing exposure to be evaluated, controlled and minimised.

Three main target groups of experts for the evaluation of the release of nano-objects from powdered nanostructured materials are:

— material scientists and engineers, who design safe nanomaterials and safe nanomaterial handling processes;

— occupational, health and safety specialists;

— environmental specialists, who need exposure data in addition to toxicity data for risk assessment of manufactured nanomaterials (see A.2) and who collect dustiness data (gravimetric as well as particle concentration and particle size information).

The propensity of nanomaterials to release nano-objects into the air is determined by test methods devised to apply energy to a sample to stress the intra-particle bonds. This stressing induces abrasion, erosion or comminution, which causes dissemination of the particles into the gaseous phase, i.e. generation of aerosols allowing quantification with aerosol instrumentation.

Methods to measure the release of nano-objects from nanomaterials may include dustiness testing methods but basic differences from conventional dustiness methods should be considered. The high variability of the flow properties of powders and the influence of the test setup should also be considered. Conventional dustiness methods for micrometre size particles estimate the amount of dust generated in terms of dust mass fraction or dustiness indices. The methods of aerosol generation for the determination of the dustiness of powders containing primary particles of less than 10 µm in diameter have been found to produce very dissimilar results.

There are a large number of possible combinations of different approaches for the design of dustiness methods[1]. The only current standard, EN 15051:2006[2], selected two methods: the rotating drum method and continuous drop method. The measured values are the inhalable, thoracic or respirable mass fractions, expressed in mg/kg.

Definitions of the inhalable, thoracic and respirable fractions can be found in EN 481[3]. Aerodynamic diameters of 100 µm, 10 µm and 4 µm are the upper limits of the corresponding size fractions. These mass fractions, which are relevant for inhalation, can be added as measurands in measurement of aerosolised nano-objects to characterize the complete particle release scenario.

Schneider and Jensen[4] described approaches using particle size distributions by number to relate exposure from nano-objects in the indoor environment to source strengths resulting from the release of nano-objects during the handling of nanostructured powders. They concluded that dustiness testing combined with online size distribution measurements provides insight into the state of agglomeration of particles released during handling of bulk powder materials.

Furthermore, the evaluation of the release of nano-objects from powdered nanostructured materials requires additional methods and measurands compared to the methods assessing the dustiness of powders. Particle number concentration and size distribution are other measurands necessary for quantifying the release of nano-objects.

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 materials can dominate relevant properties of the bulk material by particle-particle interactions that form clusters like agglomerates. There is still a lack of understanding

in the characterization of these secondary nanostructured particles, consisting of primary nano-objects. It has been shown for fumed silica, as an example, that the resulting aerosol particle size distribution depends strongly upon the conditions involved in the different measuring methods[5][6].

Aerosols and powders are also generated by tribological abrasive tests[7] of nano-composites and paints containing nanoparticles[8][9]. Such abrasion tests are not addressed by this Technical Specification. However, the measurement methodology of these publications has been proven for the quantification of nano-object release from wear powders by generation of aerosols.

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 Technical Specification provides methodology 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. In addition to information in terms of mass, the aerosol is characterized for particle concentrations and size distributions. This Technical Specification provides information on factors to be considered when selecting from 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 Technical Specification.

This Technical Specification 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 referenced documents are indispensable for the application of this document. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 27687:2008, *Nanotechnologies — Terminology and definitions for nano-objects — nanoparticle, nanofibre and nanoplate*

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

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO/TS 27687 and ISO/TS 80004-1 and the following apply.

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, released from a sample as a consequence of a disturbance

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

