SRI LANKA STANDARD 12000-Part 1:2012
ISO/TS 27687:2008

NANOTECHNOLOGIES
PART 1:TERMINOLOGY AND DEFINITIONS FOR
NANO-OBJECTS- NANOPARTICLE, NANOFIBER AND NANOPLATE

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard
NANO TECHNOLOGIES
PART 1 - TERMINOLOGY AND DEFINITIONS FOR NANO-OBJECTS- NANOPARTICLE, NANOFIBER AND NANOPLATE

SLS 12000-Part 1:2012
ISO/TS 27687:2008

Gr.D

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This standard does not purport to include all the necessary provisions of a contract.

Sri Lanka Standard
NANOTECHNOLOGIES
PART 1:TERMINOLOGY AND DEFINITIONS FOR NANO-OBJECTS-NANOPARTICLE, NANOFIBER AND NANOPLATE

NATIONAL FOREWORD

This standard was approved by the National Mirror Committee on Nanotechnology and authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2012.01.22.

This Sri Lanka Standard is identical with **ISO/TS 27687:2008** Terminology and definitions for nano-objects- Nanoparticle, nanofiber and nanoplate, published by the International Organization for Standardization (ISO).

TERMINOLOGY AND CONVENTIONS

The text of the International Standard has been accepted as suitable for publication, without any deviation as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards. Attention is therefore drawn to the following:

a) Wherever the words "International Standard" appear referring to this standard they should be interpreted as "Sri Lanka Standard".

b) The comma has been used throughout as a decimal marker. In Sri Lanka Standards, it is the current practice to use a full point on the baseline as the decimal marker.

Wherever page numbers are quoted, they are "ISO" page numbers.

CROSS REFERENCES

Corresponding Sri Lanka standards for International Standards listed under references in **ISO/TS 27687:2008** are not available.

TECHNICAL SPECIFICATION

ISO/TS 27687

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2008-08-15

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2009-02-01

Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate

Nanotechnologies — Terminologie et définitions relatives aux nano-objets — Nanoparticule, nanofibre et nanoplat

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

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— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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.

ISO/TS 27687 was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*.

In this corrected version of ISO/TS 27687:2008, the caption for Figure 1 b) has been altered, a terminology change has been made in the bottom, right-hand box of Figure 2 and the second line of the NOTE under 4.1 has been altered to align with Figure 1 b).

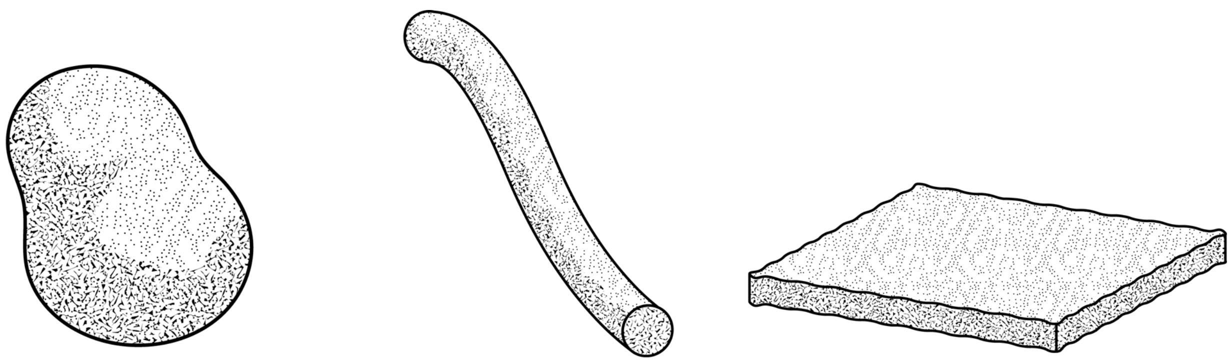
Introduction

As many authorities predict that applications of nanotechnologies will pervade all areas of life and will enable dramatic advances to be realized in all areas of communication, health, manufacturing, materials and knowledge-based technologies, there is an obvious need to provide industry and research with suitable tools to aid the development and application of those technologies. It is also essential that regulators and health and environmental protection agencies have available reliable measurement systems and evaluation protocols supported by well-founded and robust standards.

Often in the field of nanotechnologies, researchers with the aid of microscopes name materials inspired by the shape of objects found in everyday life although the physical size is much smaller. The prefix, nano-, is often added to denote the small size of the object. (The prefix nano-, is also used in S.I. units to indicate 10^{-9} e.g. 1 nanometre = 10^{-9} metre.)

To create a unitary standard, this terminology and definitions document encompasses terms used in both nanosciences and nanotechnologies concerning particles at the nano-scale. Nano-object and other new terms are coined to allow development of a rational hierarchical system of definitions. This hierarchy will allow systematic building of vocabulary and is contained in a larger hierarchy of terms under development for nanotechnologies. This document provides an up-to-date listing of terms and definitions relevant to the area. It forms one part of a projected multi-part terminology and definitions document covering the different aspects of nanotechnologies. It is intended to facilitate communications between organizations and individuals in industry and those who interact with them.

This document is concerned with the definition of terminology and definitions for these small objects. These objects come in several shapes; the three basic shapes referred to in this document are illustrated in Figure 1:



a) nanoparticle **b) nanofibre** **c) nanoplate**

Figure 1 — Schematic diagrams showing some shapes for nano-objects

There is a hierarchical relationship between many of the different terms in the document. Some elements of this are shown in Figure 2 to illustrate some of the relationships that exist.

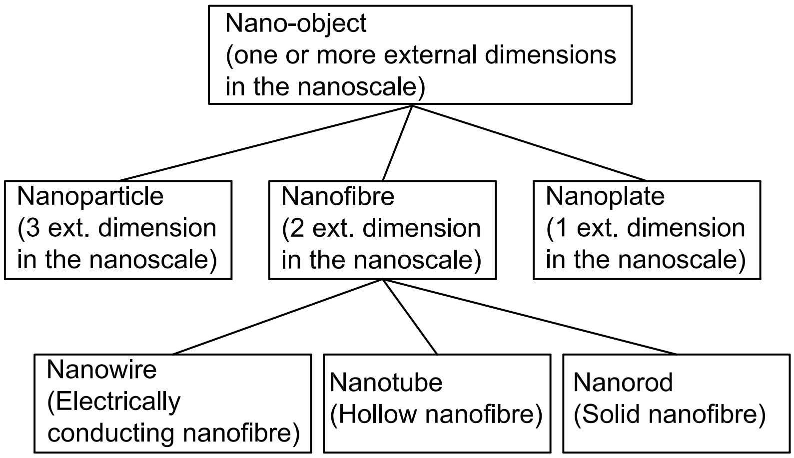


Figure 2 — Fragment of hierarchy of terms related to nano-objects

Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate

1 Scope

This Technical Specification lists terms and definitions related to particles in the field of nanotechnologies. It is intended to facilitate communications between organizations and individuals in industry and those who interact with them.

2 Core terms related to particles

2.1
nanoscale
size range from approximately 1 nm to 100 nm

NOTE 1 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 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 or elements of nanostructures, which might be implied by the absence of a lower limit.

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

NOTE Generic term for all discrete **nanoscale** objects.

3 Terms concerning particles and assemblies of particles

Nano-objects (for example nanoparticles, nanofibres, and nanoplates see Clause 4), often occur in (large) groups, rather than isolated. For reasons of surface energy, such coexisting nano-objects are likely to interact. In the description of these interactions, the following terms are often used. The following terms are not restricted with respect to physical size and shape. These terms are included for completeness and their importance at the nanoscale.

3.1
particle
minute piece of matter with defined physical boundaries

[ISO 14644-6:2007, definition 2.102]

NOTE 1 A physical boundary can also be described as an interface.

NOTE 2 A particle can move as a unit.

NOTE 3 This general particle definition applies to nano-objects.

3.2
agglomerate
collection of weakly bound **particles** or **aggregates** 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 The forces holding an **agglomerate** together are weak forces, for example van der Waals forces, or simple physical entanglement.

NOTE 2 Agglomerates are also termed secondary **particles** and the original source particles are termed primary **particles**.

3.3
aggregate
particle 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 The forces holding an **aggregate** together are strong forces, for example covalent bonds, or those resulting from sintering or complex physical entanglement.

NOTE 2 **Aggregates** are also termed secondary **particles** and the original source **particles** are termed primary **particles**.

4 Terms specific to nano-objects

4.1
nanoparticle
nano-object with all three external dimensions in the **nanoscale**

NOTE 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** or **nanoplate** are intended to be used instead of the term **nanoparticle**.

4.2
nanoplate
nano-object with one external dimension in the **nanoscale** and the two other external dimensions significantly larger

NOTE 1 The smallest external dimension is the thickness of the **nanoplate**.

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

NOTE 3 The larger external dimensions are not necessarily in the **nanoscale**.

4.3
nanofibre
nano-object with two similar external dimensions in the **nanoscale** and the third dimension significantly larger

NOTE 1 A nanofibre can be flexible or rigid.

NOTE 2 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 The largest external dimension is not necessarily in the **nanoscale**.

4.4
nanotube
hollow **nanofibre**

4.5
nanorod
solid **nanofibre**

4.6
nanowire
electrically conducting or semi-conducting **nanofibre**

4.7
quantum dot
crystalline **nanoparticle** that exhibits size-dependent properties due to quantum confinement effects on the electronic states

Annex A
(informative)

Particle size measurement

A.1 Introduction

Particle size is a fundamental attribute of disperse materials. However, the reported particle size and associated accuracy are dependent on a number of considerations.

A.2 Sampling and size distributions

A.2.1 General

Particles from either natural sources or when manufactured under carefully controlled conditions, exist as populations with a range of sizes, shapes, morphologies and compositions. For good quality measurement, a representative sample of a sufficient number of particles to adequately define the population must first be obtained. The approach needed is affected by the media surrounding the particles, and also if the particles are transferred from one media to another. An example is the deposition of particles from liquid, air or powder to a surface for exposure to a vacuum environment for electron microscopy. The particles might be altered by the different environments (e.g. semi-volatile materials may out-gas) or agglomerates might be dispersed by shear forces during measurement (e.g. in the nozzle of a cascade impactor). The transfer of particles from one medium to another might also affect how representative the sample is of the original material.

A.2.2 Measurement principles and definition of measurand

The measured size of a particle is always dependent on the particular method that is being used to examine, measure or visualise the particle. Particle size is measured by using one or a number of physical phenomena whose strength depends on the size of the particle being examined. Examples of different measurement methods are diffusion velocity in liquids, electrophoretic mobility in gases and dynamic light scattering of particles or the integrated surface area of a particle system (BET method). Any given particle will interact with its environment according to its own specific physical and chemical make-up. This means that the size of a particle reported by one technique may not be the same as the size when measured with another technique.

In many fields it has been the custom to define particle size ranges with common behaviour, sources or composition using the method of measurement embedded in the definition. An example is the term ultrafine particles defined as particles with equivalent diameters smaller than 100 nm. Equivalent diameter refers to the practice of reporting the size of a particle of unknown composition or shape as if the particle had known composition and spherical shape. For example, when the particles are measured using an inertial based instrument, aerodynamic diameter is an equivalent diameter, computed as if the particle had unity specific gravity and a spherical shape corresponding to the measured particle settling velocity. Unfortunately the term ultrafine particle is sometimes used interchangeably with the term nanoparticle. Initially, the term nanoparticle was used to describe man-made particles smaller than 100 nm with unique properties.

An additional complication is that even with a single detection method, the result depends on how the information is processed. An example is the image obtained with a microscope. Quite different results may be obtained with respect to the method used to interpret the image e.g. maximum versus minimum length of a complex particle, which are both useful but nevertheless are different measurands. In the same way as equivalent diameters, length parameters used for particle size characterization should be indicated (ISO 9276-6[6]).

As particles normally occur in populations as mentioned above, the distribution of size needs to be characterized, for instance by statistical distribution parameters such as mean and standard deviation. The selection of a mathematical form or parameters of the distribution function depends on any particular measurement requirements.

The proportions of the size classes in a population are based on the measurement type that is determined mainly by the measurement method, e.g. number for optical counting methods. Other measurement types are volume for ultrasonic spectroscopy or scattered light intensity for optical ensemble methods, which can depend on the 2nd up to the 6th power of the particle size. The necessary assumptions included in the instrument software for the conversion of intensity-based distributions into number- or volume-based distributions should be considered for the measured particles.

A.2.3 Conclusions

Measurement of particle size is a complex issue due to the fact that a large number of different indirect measurement techniques are available. This makes comparison of results from one laboratory to another difficult when different measurement methods are used, particularly when reference materials are not available. For most particle sizing methods, because of the issues described above, unambiguous metrological traceability of the measurement result to the SI unit of length cannot be established. Traceability of all used different size-dependent physical phenomena can be established, but this has not yet been carried out in most cases.

When reporting particle size measurement results, it is therefore necessary to describe the method used to determine the particle size. Often the planned use of the particle size data, e.g. product requirements or health effects, will dictate selection of the particular measurement method that is used.

A.2.4 Reference to other relevant ISO Technical Committees

Within ISO, general standards for individual particle characterization methods and for the representation of results are prepared by ISO/TC 24, *Sieves, sieving and other sizing methods*, SC 4, *Sizing by methods other than sieving*.

Standards for specific application branches of particle technology are prepared by ISO/TC 146, *Air quality*, SC 2, *Workplace atmospheres* and ISO/TC 209, *Cleanrooms and associated controlled environments*.

A.3 Terms related to measurement issues for particle size

A.3.1
specific surface area mean diameter
diameter calculated from a ratio of particle volume to specific surface area adsorption

NOTE This determination is applicable for non-porous spherical particles and often carried out by the BET method.

A.3.2
ultrafine particle
particle with **an equivalent diameter** less than 100 nm

[adapted from ISO 14644-6:2006, definition 2.137]

NOTE 1 Most nanoparticles, defined by their geometrical dimensions, are ultrafine particles, when measured.

NOTE 2 For example, a polystyrene sphere of 100 nm diameter represents the upper limit for the nanoparticle definition as well as for the ultrafine particle definition that addresses aerodynamic or mobility equivalent diameters. Porous particles have smaller equivalent optical and aerodynamic diameters than non-porous particles. Non-porous particles with higher density than polystyrene have larger aerodynamic equivalent diameters.

A.3.3
equivalent diameter
diameter of a sphere that produces a response by a given particle-sizing instrument, that is equivalent to the response produced by the particle being measured

NOTE 1 The physical property to which the equivalent diameter refers is indicated using a suitable subscript (ISO 9276-1:1998[5]).

NOTE 2 For discrete-particle-counting, light-scattering instruments, the equivalent optical diameter is used.

NOTE 3 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.

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