SRI LANKA STANDARD 12000-Part 3:2012
ISO/TS 80004-3:2010

NANOTECHNOLOGIES
- VOCABULARY-
PART 3: CARBON NANO-OBJECTS

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard
NANOTECHNOLOGIES
PART 3: VOCABULARY - CARBON NANO-OBJECTS

SLS 12000-Part 3:2012
ISO/TS 80004-3:2010

Gr.D

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

Sri Lanka Standard
NANOTECHNOLOGIES- VOCABULARY-
PART 3: CARBON NANO-OBJECTS

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 80004-3:2010** Nanotechnologies- Vocabulary- Part 3: Carbon nano-objects, 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 80004-3:2010** are not available.

SLS 12000 -3 : 2012

TECHNICAL SPECIFICATION

ISO/TS 80004-3

First edition
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Nanotechnologies — Vocabulary —

Part 3:
Carbon nano-objects

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Partie 3: Nano-objets en carbone

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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.

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:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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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 80004-3 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 3: Carbon nano-objects*

The following parts are under preparation:

— *Part 1: Core terms*

— *Part 2: Nano-objects — Nanoparticle, nanofibre and nanoplate*[1)]

— *Part 4: Nanostructured materials*

— *Part 5: Bio/nano interface*

— *Part 6: Nanoscale measurement and instrumentation*

1) ISO/TS 27687:2008 will be revised as ISO/TS 80004-2.

— *Part 7: Medical, health and personal care applications*

— *Part 8: Nanomanufacturing processes*

Introduction

In the last two decades, various new forms of nanoscale carbon materials, including fullerenes and carbon nanotubes, have been discovered, synthesized and manufactured. These are promising materials for many industrial fields associated with nanotechnologies because of their unique electronic, electromagnetic, thermal, optical and mechanical properties.

In the context of increasing scientific knowledge and a growing number of technical terms in the field of nanotechnologies (see Bibliography), the purpose of this part of ISO/TS 80004 is to define important terms and concepts for carbon nano-objects in a precise and consistent manner, in order to clarify their interrelationship, as well as their relationship to existing terms previously used for conventional carbon materials.

This part of ISO/TS 80004 belongs to a multi-part vocabulary covering the different aspects of nanotechnologies. Most of the definitions in this part of ISO/TS 80004 are deliberately determined so as to be in harmony with a rational hierarchical system of terminology under development for nanotechnologies, although in some cases the hierarchical approach needs to be compromised due to the specific usage of individual terms.

Nanotechnologies — Vocabulary —

Part 3:
Carbon nano-objects

1 Scope

This part of ISO/TS 80004 lists terms and definitions related to carbon nano-objects in the field of nanotechnologies. It is intended to facilitate communications between organizations and individuals in industry and those who interact with them.

2 Basic terms used in the description of carbon nano-objects

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.

[ISO/TS 27687:2008, definition 2.1]

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

NOTE Generic term for all discrete nanoscale objects.

[ISO/TS 27687:2008, definition 2.2]

2.3
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.

[ISO/TS 27687:2008, definition 4.1]

2.4
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.

[ISO/TS 27687:2008, definition 4.2]

2.5
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.

[ISO/TS 27687:2008, definition 4.3]

2.6
nanotube
hollow nanofibre

[ISO/TS 27687:2008, definition 4.4]

2.7
nanorod
solid nanofibre

[ISO/TS 27687:2008, definition 4.5]

2.8
nano-onion
spherical **nanoparticle** (2.3) with concentric multiple shell structure

2.9
nanocone
cone-shaped **nanofibre** (2.5) or **nanoparticle** (2.3)

2.10
nanoribbon
nanoplate (2.4) with one of its two larger dimensions in the **nanoscale** (2.1) and the other significantly larger

2.11
graphene
single layer of carbon atoms with each atom bound to three neighbours in a honeycomb structure

NOTE It is an important building block of many carbon nano-objects.

2.12
graphite
allotropic form of the element carbon, consisting of **graphene** (2.11) layers stacked parallel to each other in a three dimensional, crystalline, long-range order

NOTE 1 Adapted from the definition in the IUPAC *Compendium of Chemical Terminology* [7].

NOTE 2 There are two allotropic forms with different stacking arrangements: hexagonal and rhombohedral.

3 Terms describing specific types of carbon nanoparticles

3.1
fullerene
molecule composed solely of an even number of carbon atoms, which form a closed cage-like fused-ring polycyclic system with 12 five-membered rings and the rest six-membered rings

NOTE 1 Adapted from the definition in the IUPAC *Compendium of Chemical Terminology* [7].

NOTE 2 A well-known example is C_{60}, which has a spherical shape with an external dimension of about 1 nm.

3.2
fullerene derivative
compound that has been formed from **fullerene** (3.1) by substitution of carbon or covalent attachment of a moiety

3.3
endohedral fullerene
fullerene (3.1) with an additional atom or atoms enclosed within the fullerene shell

3.4
metallofullerene
endohedral fullerene (3.3) with an enclosed metal ion or ions

3.5
carbon nano-onion
nano-onion (2.8) composed of carbon

4 Terms describing specific types of carbon nanofibres and nanoplates

4.1
carbon nanofibre
CNF
nanofibre (2.5) composed of carbon

4.2
graphitic nanofibre
carbon nanofibre (4.1) composed of **graphene** (2.11) multilayer structures

NOTE Graphene layers can be any orientation with respect to the fibre axis without long-range order.

4.3
carbon nanotube
CNT
nanotube (2.6) composed of carbon

NOTE Carbon nanotubes usually consist of curved **graphene** (2.11) layers, including **single-wall carbon nanotubes** (4.4) and **multiwall carbon nanotubes** (4.6).

4.4
single-wall carbon nanotube
SWCNT
single-walled carbon nanotube
carbon nanotube (4.3) consisting of a single cylindrical **graphene** (2.11) layer

NOTE The structure can be visualized as a graphene sheet rolled into a cylindrical honeycomb structure.

4.5
chiral vector of SWCNT
vector notation used to describe the helical structure of a **single-wall carbon nanotube** (4.4)

4.6
multiwall carbon nanotube
MWCNT
multi-walled carbon nanotube
carbon nanotube (4.3) composed of nested, concentric or near-concentric **graphene** (2.11) sheets with interlayer distances similar to those of **graphite** (2.12)

NOTE The structure is normally considered to be many **single-wall carbon nanotubes** (4.4) nesting each other, and would be cylindrical for small diameters but tends to have a polygonal cross-section as the diameter increases.

4.7
double-wall carbon nanotube
DWCNT
double-walled carbon nanotube
multiwall carbon nanotube (4.6) composed of only two nested, concentric **single-wall carbon nanotubes** (4.4)

NOTE Although this is a type of multiwall carbon nanotube, its properties are rather closer to single-wall carbon nanotubes.

4.8
cup-stack carbon nanotube
cup-stacked carbon nanotube
carbon nanotube (4.3) composed of stacked truncated **graphene** (2.11) **nanocones** (2.9)

NOTE This is completely different from single-wall or multiwall carbon nanotubes in structure. The open top and bottom edges of truncated graphene nanocones appear on the inner and outer surfaces of the nanotube, respectively.

4.9
carbon nanopeapod
linear array of **fullerenes** (3.1) enclosed in a **carbon nanotube** (4.3)

NOTE This is an example of a composite nanofibre.

4.10
carbon nanohorn
short and irregular shaped **carbon nanotube** (4.3) with a **nanocone** (2.9) apex

NOTE Usually hundreds of carbon nanohorns constitute an aggregate nanoparticle.

4.11
carbon nanoribbon
nanoribbon (2.10) composed of carbon

NOTE Carbon nanoribbons are often in the form of multiple layers of **graphene** (2.11). In the case of a single graphene layer, the term graphene ribbon is used.

Annex A
(informative)

Related carbon nanoscale materials

A.1 General

There are many kinds of conventional carbon materials which have been produced and used widely in industry for many years. Some of them may fall into the category of nanotechnologies in view of substantial recent progress in controlling their nanoscale dimensions. However, the terms associated with them are viewed as satisfactory at this time and need not be redefined in this part of ISO/TS 80004.

A.2 Diamond nanoparticles and related structures

Diamond nanoparticles (often called "nanodiamond") are related to a large group of carbon materials with very different production methods (e.g. explosive methods, chemical vapour deposition, physical vapour deposition), appearance, size, properties and application. Some diamond-based nanoparticles, such as diamondoids, occur naturally and can be extracted from hydrocarbon deposits. Some of the terms and definitions associated with diamond nanoparticles are listed in BS PAS 134: 2007 [3].

A.3 Carbon films

Carbon films have been used commercially in the coatings industry to impart certain properties to materials. Carbon films can be produced using a variety of different techniques, such as cathodic arc and magnetron sputtering. There are various terms used in the literature for carbon based coatings, e.g. diamond-like carbon (DLC), glassy carbon and tetrahedral amorphous carbon. Basically, these films differ by the various fractions of sp^2, sp^3 hybridization and hydrogen content within them. For example, diamond-like carbon is typically used to reduce abrasive wear, while glassy carbon is used where resistance to high temperatures, chemical attack and gas or liquid impermeability is required. Some of the terms and definitions associated with carbon films are listed in BS PAS 134: 2007 [3].

A.4 Carbon black

Carbon black is an industrially manufactured colloidal carbon material in the form of spheres and of their aggregates with sizes below 1 000 nm (see the IUPAC *Compendium of Chemical Terminology* [7]). The size of a primary particle is typically between 5 nm and 50 nm. Carbon black is most commonly used as reinforcement in rubber tyres and also as a pigment for inks, paints and toners. It is manufactured by thermal decomposition, including detonation, or by incomplete combustion of hydrocarbon compounds, and has a well-defined morphology with a minimum content of tars or other extraneous materials. Carbon black is distinguished from soot, which is randomly formed, on the basis of tar, ash content and impurities.

Bibliography

[1] ISO/TS 27687:2008[2], *Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate*

[2] BS PAS 71: 2005, *Vocabulary — Nanoparticles*

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2) To be revised as ISO/TS 80004-2.

Alphabetical index

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The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Technology & Research.

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