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**Nanotechnologies — Vocabulary —  
Part 3:  
Carbon nano-objects**

*Nanotechnologies — Vocabulaire —*

*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;
- 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order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn.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again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.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 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<sup>1)</sup>*
- *Part 4: Nanostructured materials*
- *Part 5: Bio/nano interface*
- *Part 6: Nanoscale measurement and instrumentation*

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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*

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## 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.

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# 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.

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### 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<sub>60</sub>, 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

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### 4 Terms describing specific types of carbon nanofibres and nanoplates

#### 4.1 carbon nanofibre CNF

**nanofibre** (2.5) composed of carbon

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#### 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.