
Nanotechnologies — Vocabulary —
Part 3:
Carbon nano-objects

Nanotechnologies — Vocabulaire —
Partie 3: Nano-objets carbonés

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

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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 229, *Nanotechnologies*, 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 80004-3:2010), which has been technically revised throughout.

A list of all parts in the ISO/TS 80004 series can be found on the ISO website.

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

In the last three decades, various new forms of nanoscale carbon materials, including fullerenes, graphene 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 the Bibliography), the purpose of this document is to define important terms and concepts for carbon nano-objects in a precise and consistent manner, while clarifying their interrelationship, as well as their relationship, to existing terms previously used for conventional carbon materials.

This document belongs to a multi-part vocabulary covering the different aspects of nanotechnologies. Most of the definitions in this document 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. ISO/TS 80004-13 further complements this document by providing terms and definitions for graphene and related two-dimensional (2D) materials. A subset of these terms is only noted herein.

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Nanotechnologies — Vocabulary —

Part 3: Carbon nano-objects

1 Scope

This document defines terms related to carbon nano-objects in the field of nanotechnologies.

It is intended to facilitate communication between organizations' and individuals' research, industry and other interested parties and those who interact with them. Additional terms and definitions for graphene and two-dimensional materials (2D) materials are provided in ISO/TS 80004-13.

Related carbon nanoscale materials are given in [Annex A](#).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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 Basic terms used in the description of carbon nano-objects

3.1.1 nanoscale

length range approximately from 1 nm to 100 nm

Note 1 to entry: Properties that are not extrapolations from a larger size are predominantly exhibited in this length range.

[SOURCE: ISO/TS 80004-1:2015, 2.1]

3.1.2 nanomaterial

material with any external dimension in the *nanoscale* (3.1.1) or having internal structure or surface structure in the nanoscale

Note 1 to entry: This generic term is inclusive of *nano-object* (3.1.3) and *nanostructured material* (3.1.4).

Note 2 to entry: See also “engineered nanomaterial”, “manufactured nanomaterial” and “incidental nanomaterial”.

[SOURCE: ISO/TS 80004-1:2015, 2.4]

3.1.3 nano-object

discrete piece of material with one, two or three external dimensions in the *nanoscale* (3.1.1)

Note 1 to entry: The second and third external dimensions are orthogonal to the first dimension and to each other.

[SOURCE: ISO/TS 80004-1:2015, 2.5]

3.1.4

nanostructured material

material having internal nanostructure or surface nanostructure

Note 1 to entry: This definition does not exclude the possibility for a *nano-object* (3.1.3) to have internal structure or surface structure. If external dimension(s) are in the *nanoscale* (3.1.1), the term “nano-object” is recommended.

[SOURCE: ISO/TS 80004-1:2015, 2.7]

3.1.5

nanoparticle

nano-object (3.1.3) with all external dimensions in the *nanoscale* (3.1.1) where the lengths of the longest and the shortest axes of the nano-object do not differ significantly

Note 1 to entry: If the dimensions differ significantly (typically by more than three times), terms such as *nanofibre* (3.1.7) or *nanoplate* (3.1.6) may be preferred to the term “nanoparticle”.

[SOURCE: ISO/TS 80004-2:2015, 4.4]

3.1.6

nanoplate

nano-object (3.1.3) with one external dimension in the *nanoscale* (3.1.1) and the other two external dimensions significantly larger

Note 1 to entry: The larger external dimensions are not necessarily in the *nanoscale*.

Note 2 to entry: See 3.1.3, Note 1 to entry. The smallest external dimension is the thickness of the nanoplate.

[SOURCE: ISO/TS 80004-2:2015, 4.6, modified — Note 2 to entry has been replaced.]

3.1.7

nanofibre

nano-object (3.1.3) with two external dimensions in the *nanoscale* (3.1.1) and the third dimension significantly larger

Note 1 to entry: The largest external dimension is not necessarily in the *nanoscale*.

Note 2 to entry: The terms “nanofibril” and “nanofilament” can also be used.

Note 3 to entry: See 3.1.3, Note 1 to entry. Nano-object with two similar external dimensions in the *nanoscale* and the third dimension significantly larger.

[SOURCE: ISO/TS 80004-2:2015, 4.5, Note 3 to entry has been replaced.]

3.1.8

nanotube

hollow *nanofibre* (3.1.7)

[SOURCE: ISO/TS 80004-2:2015, 4.8]

3.1.9

nanorod

solid *nanofibre* (3.1.7)

[SOURCE: ISO/TS 80004-2:2015, 4.7]

3.1.10

nano-onion

spheroidal *nanoparticle* (3.1.5) with a concentric multiple shell structure

3.1.11**nanocone**

cone-shaped *nanofibre* (3.1.7) or *nanoparticle* (3.1.5)

3.1.12**nanoribbon**

nanotape

nanoplate (3.1.6) with the two larger dimensions significantly different from each other

Note 1 to entry: See 3.1.3, Note 1 to entry.

[SOURCE: ISO/TS 80004-2:2015, 4.10]

3.1.13**graphene**

monolayer graphene

single-layer graphene

single *layer* (3.1.15) of carbon atoms with each atom bound to three neighbours in a honeycomb structure

Note 1 to entry: It is an important building block of many carbon *nano-objects* (3.1.3).

Note 2 to entry: As graphene is a single layer, it is also sometimes called “monolayer graphene” or “single-layer graphene” and abbreviated as “1LG” to distinguish it from *bilayer graphene* (2LG) (3.1.17) and *few-layer graphene* (FLG) (3.1.18).

Note 3 to entry: Graphene has edges and can have defects and grain boundaries where the bonding is disrupted.

[SOURCE: ISO/TS 80004-13:2017, 3.1.2.1]

3.1.14**graphite**

allotropic form of the element carbon, consisting of *graphene* (3.1.13) layers stacked parallel to each other in a three-dimensional, crystalline, long-range order

Note 1 to entry: Adapted from the definition in the IUPAC *Compendium of Chemical Terminology*^[6].

Note 2 to entry: There are two primary allotropic forms with different stacking arrangements: hexagonal and rhombohedral.

[SOURCE: ISO/TS 80004-13:2017, 3.1.2.2]

3.1.15**layer**

discrete material restricted in one dimension, within or at the surface of a condensed phase

[SOURCE: ISO/TS 80004-11:2017, 3.1.2]

3.1.16**two-dimensional material****2D material**

material, consisting of one or several *layers* (3.1.15) with the atoms in each layer strongly bonded to neighbouring atoms in the same layer, which has one dimension, its thickness, in the *nanoscale* (3.1.1) or smaller and the other two dimensions generally at larger scales

Note 1 to entry: The number of layers when a two-dimensional material becomes a bulk material varies depending on both the material being measured and its properties. In the case of *graphene* (3.1.13), it is a two-dimensional material up to 10 layers thick for electrical measurements^[2], beyond which the electrical properties of the material are not distinct from those for the bulk [also known as *graphite* (3.1.14)].

Note 2 to entry: Interlayer bonding is distinct from and weaker than intralayer bonding.

Note 3 to entry: Each layer may contain more than one element.