
**Nanotechnologies — Vocabularies
for science, technology and
innovation indicators**

*Nanotechnologies — Vocabulaires pour la science, la technologie et
les indicateurs d'innovation*

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 229, *Nanotechnologies*.

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Introduction

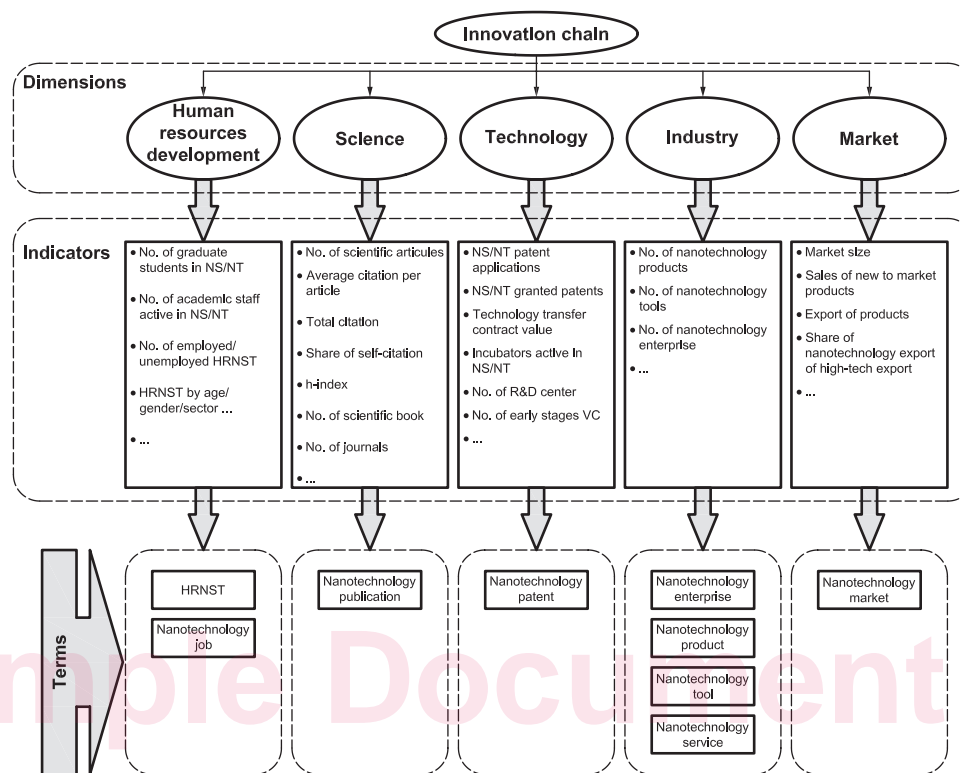
Emerging nanotechnologies are moving towards commercialization and will in future create extensive economic benefits in various industrial sectors. In this field, monitoring trends and the rate of changes in science, technology and industry at global, regional and domestic levels is an important consideration. Due to the high levels of investment by the private, public and industrial sectors and the substantial increase in nanotechnology-based publications, inventions and products, a unified approach is required to evaluate the impact of these investments, as well as the overall progress and impact of nanotechnology.

Understanding the socio-economic impacts of nanotechnology is important among communities. Investors, for example, require the assessment of scientific and technological advancements, while policy makers are interested in the assessment of results and impacts of their policies and programs.

The basic efforts of ISO/TC 229 for the standardization of nanotechnology-related terms were an important step towards the creation of a common language to inform people of nanotechnology development worldwide. Most of the terminology projects have focused on the development of scientific and technological vocabularies and terms. The creation of terms and core terms for science, technology and innovation indicators are of great interest, especially where existing indicators are inadequate for applications relating to nanotechnology. Such terms would help transparent and trustworthy comparison of international activities in this area. Unfortunately, due to the lack of such globally agreed vocabularies/definitions, the released economic, scientific and innovation statistics should be considered with caution.

[Figure 1](#) typically demonstrates the major dimensions of the nanotechnology innovation chain as human resources development, science, technology, industry and market. For each of these dimensions, there are several relevant indicators, which are utilized to varying degrees in some analytical reports related to nanotechnology.

Generic indicators that are descriptive of innovation dimensions are already well defined; however, the bounds of these indicators as they relate to nanotechnology need to be defined and harmonized to ensure consistent reporting.



Key

- NS nanoscience
- NT nanotechnology

NOTE Adopted from References [15] and [28].

Figure 1 — Demonstration of innovation chain dimensions, indicators and defined terms

Nanotechnologies — Vocabularies for science, technology and innovation indicators

1 Scope

This Technical Specification aims to provide the necessary definitions that specify the bounds of key innovation indicators as they relate to nanotechnology, in order to facilitate and unify the global assessment of nanotechnology activities in different areas.

The availability of these terms can help the measurement and comparison of various indicators in this field. This Technical Specification does not intend to redefine terms that are already defined in other ISO documents. Furthermore, there is no intention to show how the indicators can be used as an assessment tool.

2 Terms and definitions from ISO 14040, ISO 14041 and ISO/TS 80004-1

The terms and definitions in this Clause are from ISO 14040, ISO 14041, and ISO/TS 80004-1. They are reproduced here for context and better understanding.

2.1

engineered nanomaterial

nanomaterial (2.8) designed for a specific purpose or function

[SOURCE: ISO/TS 80004-1:2015, 2.8]

2.2

final product

product which requires no additional transformation prior to its use

[SOURCE: ISO 14041:1998, 3.6]

2.3

intermediate product

output from a unit process that is input to other unit processes that require further transformation within the system

[SOURCE: ISO 14040:2006, 3.23]

2.4

manufactured nanomaterial

nanomaterial (2.8) intentionally produced to have selected properties or composition

[SOURCE: ISO/TS 80004-1:2015, 2.9]

2.5

nano-enabled

exhibiting function or performance only possible with *nanotechnology* (2.13)

[SOURCE: ISO/TS 80004-1:2015, 2.15]

2.6

nano-enhanced

exhibiting function or performance intensified or improved by *nanotechnology* (2.13)

[SOURCE: ISO/TS 80004-1:2015, 2.16]

ISO/TS 18110:2015(E)

2.7

nanomanufacturing process

ensemble of activities to intentionally synthesize, generate or control *nanomaterials* (2.8), or fabrication steps in the *nanoscale* (2.9), for commercial purpose

[SOURCE: ISO/TS 80004-1:2015, 2.12]

2.8

nanomaterial

material with any external dimension in the *nanoscale* (2.9) or having internal structure or surface structure in the *nanoscale*

Note 1 to entry: This generic term is inclusive of nano-object and nanostructured material.

Note 2 to entry: See also *engineered nanomaterial* (2.1), *manufactured nanomaterial* (2.4) and incidental nanomaterial.

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

2.9

nanoscale

length range approximately from 1 nm to 100 nm

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

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

2.10

nanoscale phenomenon

effect attributable to the presence of nano-objects or *nanoscale* (2.9) regions

[SOURCE: ISO/TS 80004-1:2015, 2.13]

2.11

nanoscale property

characteristic of a nano-object or *nanoscale* (2.9) region

[SOURCE: ISO/TS 80004-1:2015, 2.14]

2.12

nanoscience

study, discovery and understanding of matter where size- and structure-dependent properties and phenomena manifest, predominantly in the *nanoscale* (2.9), distinct from those associated with individual atoms or molecules, or extrapolation from larger sizes of the same material

[SOURCE: ISO/TS 80004-1:2015, 2.2]

2.13

nanotechnology

application of scientific knowledge to manipulate and control matter predominantly in the *nanoscale* (2.9) to make use of size- and structure-dependent properties and phenomena distinct from those associated with individual atoms or molecules, or extrapolation from larger sizes of the same material

Note 1 to entry: Manipulation and control includes material synthesis.

[SOURCE: ISO/TS 80004-1:2015, 2.3]

3 Terms and definitions for science, technology and innovation indicators

Further information relating to definitions in this Clause can be found in informative [Annexes A to G](#).

3.1**human resources for nanoscience and nanotechnology
HRNST**

people who have:

- a) successfully completed education at the university level in *nanoscience* (2.12) (NS) or *nanotechnology* (2.13) (NT) majors, or
- b) successfully graduated in majors other than NS/NT majors, but completed a requirement of the major in the field of NS/NT, or
- c) not formally qualified as above, but are employed in a *nanotechnology job* (3.2)

3.2**nanotechnology job**

job whose main tasks and duties use *nanotechnology* (2.13)

Note 1 to entry: Regarding the potential of nanotechnology to establish new enterprises and facilities, an indicator may be measured as “*job created by nanotechnology*”. This indicator includes nanotechnology jobs as well as other job opportunities in these establishments which do not necessarily use nanotechnology.

3.3**nanotechnology publication**

science-based publication that publishes information about *nanotechnology* (2.13), its applications and implications

Note 1 to entry: Those publications may also include socio-economic aspects of nanotechnology.

3.4**nanotechnology patent**

any patent related to *nanotechnology* (2.13)

Note 1 to entry: Such patents include *nanotechnology product* (3.5), *nanotechnology tool* (3.6), production process of nanotechnology product and *nanomanufacturing process* (2.7).

Note 2 to entry: Such patents would be considered under the IPC/CPC classes and related subclasses, such as B82, or contain at least one claim related to *nanotechnology* (2.13).

3.5**nanotechnology product**

one or more of:

- a) *manufactured nanomaterial* (2.4) or *engineered nanomaterial* (2.1)
- b) *nano-enhanced* (2.6)/*nano-enabled* (2.5) *intermediate product* (2.3)
- c) *nano-enhanced* (2.6)/*nano-enabled* (2.5) *final product* (2.2)

Note 1 to entry: Within supply chains, an intermediate product may be considered as a final product, however, process intermediates are excluded.

Note 2 to entry: Final products which are assembled with one or a number of nanotechnology final products as components or parts should not be considered as nanotechnology products. This exclusion prevents multiple counting of nanotechnology final products in a product value chain.

3.6**nanotechnology tool**

means for analysis, manipulation or fabrication of *nanomaterial* (2.8) or *nanotechnology product* (3.5)

Note 1 to entry: Analysis of nanomaterial includes studying and measuring *nanoscale phenomena* (2.10) and *nanoscale properties* (2.11).

Note 2 to entry: In some instances fabrication may include *nanomanufacturing processes* (2.7).