
**Nanotechnologies — Model taxonomic
framework for use in developing
vocabularies — Core concepts**

*Nanotechnologies — Modèle de cadre taxinomique pour utilisation dans
le développement de vocabulaires — Concepts de base*

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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 exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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/TR 12802 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.

Other vocabulary documents developed by ISO/TC 229 and IEC/TC 113 include the ISO/IEC 80004 series, which consists of the following parts, under the general title *Nanotechnologies — Vocabulary*:

- ISO/TS 80004-1, *Nanotechnologies — Vocabulary — Part 1: Core terms*
- ISO/TS 80004-3, *Nanotechnologies — Vocabulary — Part 3: Carbon nano-objects*

The following parts are under preparation:

- ISO/TS 80004-4, *Nanotechnologies — Vocabulary — Part 4: Nanostructured materials*
- ISO/TS 80004-5, *Nanotechnologies — Vocabulary — Part 5: Bio/nano interface*
- ISO/TS 80004-6, *Nanotechnologies — Vocabulary — Part 6: Nanoscale measurement and instrumentation*
- ISO/TS 80004-7, *Nanotechnologies — Vocabulary — Part 7: Medical, health and personal care applications*
- ISO/TS 80004-8, *Nanotechnologies — Vocabulary — Part 8: Nanomanufacturing processes*

ISO/TS 27687:2008, *Nanotechnologies — Terminology and definitions for nano-objects — Nanoparticle, nanofibre and nanoplate* will be revised as ISO/TS 80004-2, *Nanotechnologies — Vocabulary — Part 2: Nano-objects: Nanoparticle, nanofibre and nanoplate*.

Introduction

This Technical Report provides a possible model taxonomic framework of core concepts for nanotechnology. The framework identifies the basic categories of nanotechnology, as well as the core concepts within these categories, and displays them in a hierarchical structure. From the core concepts, a list of core terms to be defined has been identified. Definitions for these terms will be developed in ISO/TS 80004-1, *Nanotechnologies — Vocabulary — Part 1: Core terms*. Definitions for terms in subject-related areas will be developed in other ISO/IEC Technical Specifications in the ISO/TS 80004 vocabulary series. See list in the Foreword

Communication is crucial to scientific practitioners, industry and trade, and regulatory bodies. Due to different backgrounds and needs, there can be widely divergent understandings and assumptions about concepts. The result is poor communication, a lack of interoperability among systems, and duplication of effort as different groups strive to define concepts in accordance with their perspectives.

A taxonomic framework of core terms is intended to place nanotechnology concepts into context by indicating relationships among these concepts. Such context can provide users with a structured view of nanotechnology and facilitates common understanding of nanotechnology concepts. Jointly, the model framework together with the core term definitions will be beneficial to industry, consumers, governments, and regulatory bodies because they promote clear, accurate and useful communication. Because the taxonomic framework looks at nanotechnology from a number of different viewpoints, it will minimize duplication of effort among stakeholders and assist in developing a harmonized vocabulary of terms.

This Technical Report attempts to remain current with the present usage of terms in this Technical Report and with the ongoing work by ISO/TC 229 and IEC/TC 113 to define such terms. However, definitions within the field of nanotechnologies are still evolving. Updating of this framework model for core concepts in concurrence with development of ISO/IEC vocabulary for nanotechnologies is recommended.

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Nanotechnologies — Model taxonomic framework for use in developing vocabularies — Core concepts

1 Scope

This Technical Report establishes core concepts for nanotechnology in a model taxonomic framework. It is intended to facilitate communication and promote common understanding.

2 Purpose of the framework development

Taxonomy is a hierarchical classification of the things in a subject domain. It places the domain's concepts into relevant categories and shows the relationships among concepts. A core concept is one of the central concepts that define a subject domain. In taxonomy, these concepts are found at the topmost levels of the hierarchy.

A taxonomic framework for core nanotechnology concepts would have several purposes. As a representation of the professional judgment of an international group of scientists, it is a depiction of current understanding of the subject, its structure and relationships. It is considered to be a snapshot of the subject domain at a particular time and is intended to be revisited and updated as the domain develops. As well, because it deals only with the top layers of the nanotechnology hierarchy, it is considered to be a model framework from which development of deeper layers in the hierarchy should begin. Finally, this framework can be used as the basis for the development of terms and definitions for nanotechnology vocabulary.

3 Methodology

A library science approach is taken to create the taxonomy using ANSI/NISO Z39.19-2005 [1] and ISO 2788:1986 [2] as its foundation. Key concepts are categorized and, where possible, placed into hierarchical structures illustrated as framework diagrams in Clause 4, Framework development. Where a hierarchy could not be created a framework is presented as a basis for future hierarchy development.

The following steps created the core concept framework diagrams:

- Development of lists of concepts considered to be central to nanotechnology.
- Completion of a categorization exercise in which concepts were sorted in accordance with their similarities and differences.
- Building of hierarchical diagrams.

Framework and hierarchy illustrations are found in Clause 4, Framework development. For project methodology steps see Annex A.

Principles followed to ensure consistency:

- Things occurring naturally in the nanoscale are not addressed in this report.

- Certain terms under consideration have a common or established definition that renders them inappropriate to include in a core concepts framework specific for nanotechnology. For example in the “properties” framework development, it is necessary to include common terms to place terms specific to nanotechnology into their proper contexts.
- The term “nanoscale” is fundamental to nanotechnology and nanoscience and is a term defined in ISO/TS 27687:2008 [3], definition 2.1.

4 Framework development

The frameworks and hierarchies presented here provide starting points to support and guide the development of vocabulary for nanotechnologies. The frameworks are provided with the intention that they are to be altered and/or expanded on a hierarchical basis based on further expert input as knowledge and understanding evolves.

4.1 Fields of activity at the nanoscale

4.1.1 Diagram

The Fields of activity at the nanoscale framework diagram is shown in Figure 1. In this diagram the term “nanoscale” overarches nanotechnology and nanoscience.

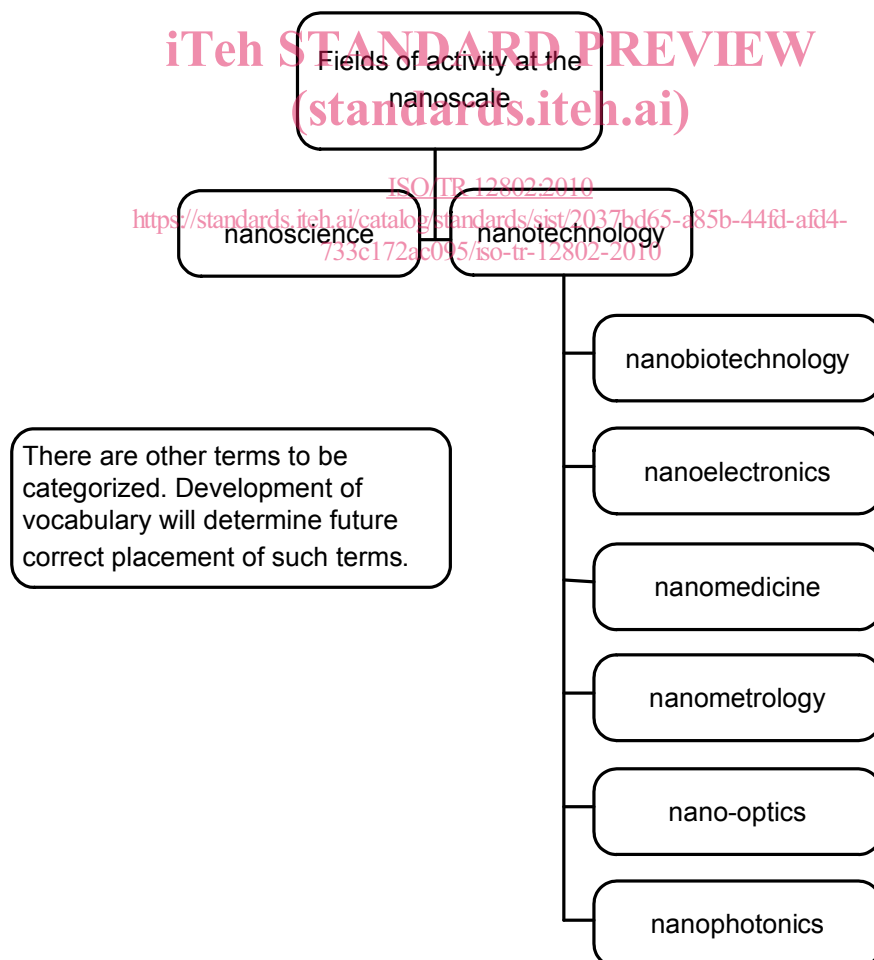


Figure 1 — Fields of activity at the nanoscale framework diagram

4.1.2 Discussion

The terms “nanoscience” and “nanotechnology” are indicated as equivalent hierarchy-level terms. The Figure 1 framework diagram is recommended to be additionally populated in subsequent editions, based on vocabulary developed in ISO/IEC Technical Specifications, *Nanotechnology — Vocabulary* (see list in the Foreword).

4.1.3 Advantages and disadvantages of the Fields of activity at the nanoscale framework

Arranging higher level concepts provides a short list of concepts that already have broad usage in literature and highlights a distinction between the scientific study of nanomaterials and the range of technological endeavours. The list of technologies provided is meant to be illustrative, not exhaustive, and should not be misinterpreted as excluding other legitimate areas that can be considered as being within the domain of nanotechnology.

4.2 Nanomaterial

4.2.1 Diagram

The Nanomaterials framework diagram is shown in Figure 2.

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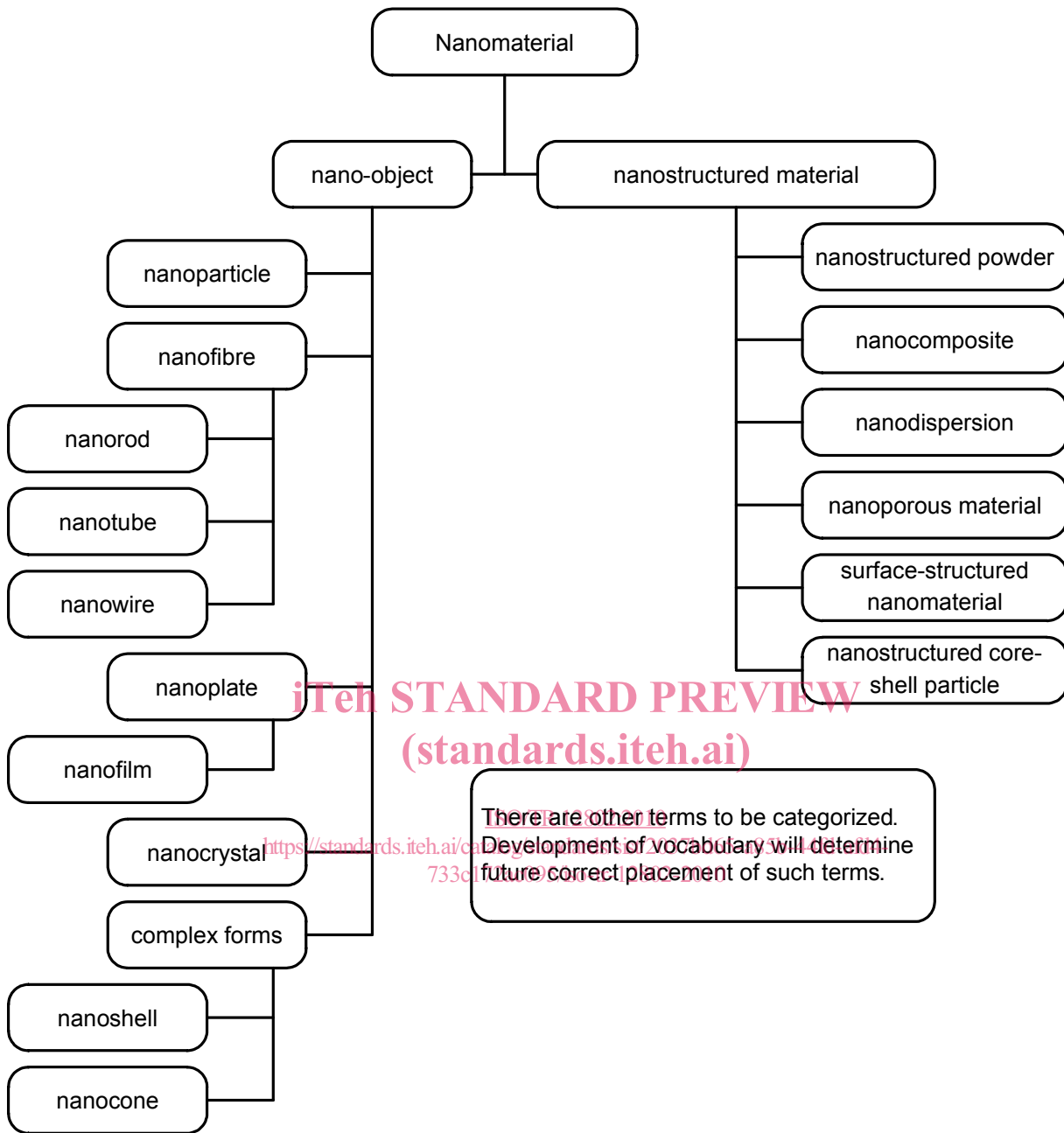


Figure 2 — Nanomaterial framework diagram

4.2.2 Discussion of the nano-object branch of the nanomaterials framework

This branch of the framework is developed as a hierarchy. The concept “ultrafine particle” is omitted from the hierarchy, consistent with ISO/TS 27687:2008 [3], A.3.2, Note, “Most nanoparticles, defined by their geometrical dimensions, are ultrafine particles, when measured”. In addition:

- The concept “nanofibre” is the overarching concept that includes “nanorod”, “nanotube”, and “nanowire” ISO/TS 27687:2008 [3], Figure 2.
- Several concepts (“nanofilm” under “nanoplate”, “nanocrystal”, “nanoshell” and “nanocone” under “complex forms”) are placed under different subsections and levels pending future revision in this framework based on terminology and definitions developed in ISO/IEC Technical Specifications, *Nanotechnology — Vocabulary* (see list in the Foreword).

- “Carbon nanotube” is a concept that would be found deeper in the hierarchy under “nanotube”. Carbon-based nano-objects are the subject of ISO/TS 80004-3, *Nanotechnology — Vocabulary — Part 3: Carbon nano-objects*.

4.2.3 Discussion of the nanostructured material branch of the nanomaterials framework

This branch is not developed as a hierarchy. The further development of core concepts for this branch remains under consideration during development of Technical Specification ISO/TS 80004-4, *Nanotechnology — Vocabulary — Part 4: Nanostructured materials*.

4.2.4 Advantages and disadvantages of the nanomaterials framework

The primary utility of the nanomaterials framework is to identify concepts and terms whose definitions will help in properly categorizing the subject domain. For some, nanocrystalline means having a crystalline structure, which may be in the shape of a nanoparticle, nanofibre or nanoplate. For others, it is part of a larger object, but one that might place it in the nanostructured material category. The inclusion of a “complex forms” sub-branch implies that just particle, fibre, and plate categories are insufficient. The “complex forms” sub-branch may need to be further populated, and concepts re-visited and placed accordingly when terminology and definitions are further developed in ISO/IEC Technical Specifications, *Nanotechnology — Vocabulary* (see list in the Foreword).

4.3 Processes

4.3.1 Diagram

The Processes framework diagram is shown in Figure 3.

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