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Technical Specification

ISO/DTS 80004-12

Nanotechnologies — Vocabulary —

Part 12: Quantum phenomena in nanotechnology

Nanotechnologies — Vocabulaire —

Partie 12: Phénomènes quantiques dans les nanotechnologies

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Foreword

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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 document 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 or www.iec.ch/members_experts/refdocs).

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This second edition cancels and replaces the first edition (ISO/TS 80004-12:2016), which has been technically revised.

The main changes are as follows:

— addition of information on general quantum concepts and effects (see 3.2), phenomena resulting from quantum effects (see 3.3); and quantum technologies (see 3.4);

— revision of references (see Bibliography).

A list of all parts in the ISO 80004 series can be found on the ISO and IEC websites.

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 and www.iec.ch/national-committees.

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Introduction

The interplay between nanoscale materials and quantum phenomena is a foundational aspect of both nanotechnology and quantum technologies. As materials are reduced to the nanometer scale, quantum effects such as energy level quantization and tunnelling become increasingly significant due to spatial confinement in one, two, or three dimensions. These effects give rise to novel, size-dependent properties governed by the principles of quantum physics. While not limited to the nanoscale, their manifestation at this scale is critical for identifying nano-enabled products and advancing both nano- and quantum technology fields.

Table 1 summarizes the relationship between the three major domains of quantum technologies: computing and simulation, communication, and sensing and metrology, together with their associated devices and enabling materials. Representative examples include qubit systems, quantum sensors, and single-photon sources, which rely on materials such as superconductors, semiconductors, topological systems, cold atoms, and Bose–Einstein condensates. Nanotechnology provides the methods to fabricate, control, and integrate these materials and devices, thereby accelerating both fundamental research and technological applications.

Table 1 — Relationship between quantum technologies, devices and platforms, and enabling materials

Quantum technologies	Devices and platforms	Enabling materials
Quantum computing and simulation	Qubit platforms; Quantum-confined structures; Quantum tunnelling devices; Quantum exchange structures	Superconductors; Semiconductors; Topological materials; Ferroelectric materials; Bose–Einstein condensates
Quantum communication	Single-photon sources and detectors; Quantum repeaters; QKD devices; Satellite links; Photonic and plasmonic circuits	Nonlinear optical crystals; Defect-engineered materials; Plasmonic & photonic materials
Quantum sensing and metrology	Quantum sensors; NV-centre-based sensors; Atomic clocks; Quantum inertial sensors; Quantum-enhanced imaging	Cold atoms; Rydberg atoms; Defect-engineered materials; Bose–Einstein condensates; Exciton–polaritons; Nonlinear optical crystals

This document supports the harmonization of quantum-related terms within the broader nanotechnology framework to promote clear and consistent communication among stakeholders in industry, academia, government, and non-profit sectors.

The document is structured to progress from background terminology to general quantum concepts, phenomena resulting from quantum effects, and terminology related to quantum technologies, including materials, nanoscale enabling devices and technologies, qubit types, application sectors, and enabling systems and integration technologies. Together, these terms provide a common vocabulary for concepts at the intersection of quantum and nanoscale domains.

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Nanotechnologies — Vocabulary —

Part 12: Quantum phenomena in nanotechnology

1 Scope

This document defines terms related to quantum phenomena relevant to nanotechnologies.

This document is applicable to terminology used in describing quantum phenomena, quantum effects, and quantum-enabled materials, devices, systems, and applications within the broader nanotechnology framework.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Background terms

3.1.1
model
physical, mathematical, or otherwise appropriate representation of a system, entity, phenomenon, process, or data

[SOURCE: ISO/IEC 4879:2024, 3.1.1]

3.1.2
operator
mathematical entity that transforms the elements of an input space to the elements of an output space

Note 1 to entry: In *quantum physics* (3.2.4), simple operators can be mathematically represented by a matrix that acts via matrix multiplication on vectors in a *Hilbert space* (3.2.1)

[SOURCE: ISO/IEC 4879:2024, 3.2.2]

3.1.3
simulator
device, computer program, or system that behaves or operates like a given system when provided a set of controlled inputs

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3750]

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