



BSI Standards Publication

Nanoparticles – Vocabulary

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Summary of pages

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Foreword

This PAS was commissioned by the Department of Business, Innovation and Skills (BIS) and its development was facilitated by the British Standards Institution (BSI). It came into effect on 31 August 2011.

Acknowledgement is given to the following organizations that were involved in the development of this PAS as members of the Steering Group:

- Health and Safety Executive
- Institute of Occupational Medicine
- Ionbond
- Malvern Instruments
- Nanotechnology Knowledge Transfer Network
- National Physical Laboratory
- Co-opted

Acknowledgement is also given to the organizations, individuals and BSI/CEN/ISO technical committees that submitted comments as members of the Review Panel.

BSI retains ownership and copyright of this PAS. BSI reserves the right to withdraw or amend this PAS on receipt of authoritative advice that it is appropriate to do so. This PAS will be reviewed at intervals not exceeding two years, and any amendments arising from the review will be published as an amended PAS and publicized in *Update Standards*.

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a standard to be rapidly developed in order to fulfil an immediate need in industry. A PAS may be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Supersession

This PAS supersedes PAS 71:2005, which is withdrawn.

Relationship with other publications

This PAS is issued as part of a suite of nanotechnology terminology PASs which also includes:

PAS 131:2007, *Terminology for medical, health and personal care applications of nanotechnologies*

PAS 132:2007, *Terminology for the bio-nano interface*

PAS 133:2007, *Terminology for nanoscale measurement and instrumentation*

PAS 134:2007, *Terminology for carbon nanostructures*

PAS 135:2007, *Terminology for nanofabrication*

PAS 136:2007, *Terminology for nanomaterials*

The terms and definitions in this PAS are taken from international standards where possible. In particular, from the emerging suite of

international nanotechnology vocabularies, which at the time of publication includes:

- DD CEN ISO/TS 27687:2009, *Nanotechnologies – Terminology and definitions for nano-objects – Nanoparticle, nanofibre and nanoplate*
- DD ISO/TS 80004-1:2010, *Nanotechnologies – Vocabulary – Part 1: Core terms*
- DD ISO/TS 80004-3:2010, *Nanotechnologies – Vocabulary – Part 3: Carbon nano-objects*

Information about this document

This is a full revision of PAS 71:2005 and introduces changes that reflect a number of developments that have taken place in the field of terminology for nanotechnologies.

Firstly the ISO technical committee for nanotechnologies, ISO/TC 229, established at the same time as PAS 71:2005, has now published three vocabularies that have been adopted by BSI. These are DD CEN ISO/TS 27687:2009, DD ISO/TS 80004-1:2010 and DD ISO/TS 80004-3:2010. Some of the definitions adopted in these vocabularies differ from those originally published in PAS 71.

Secondly the BSI technical committee for nanotechnologies, NTI/1, has published another six vocabularies, PAS 131:2007 to PAS 136:2007. These are available for free download at www.bsigroup.com/nano. Again some of the definitions adopted in these vocabularies differ from those originally published in PAS 71.

Therefore, those terms and definitions in PAS 71:2005 that have since been defined differently in subsequent nanotechnology vocabularies have been updated as part of this revision. Such terms and definitions are followed by references to the vocabularies from which they are taken.

In the meantime, ISO/TC 229 is continuing its development of additional internationally agreed vocabularies, some of which are based on PAS 131 to PAS 136. At such a time that equivalent ISO vocabularies are published, existing PAS vocabularies will be withdrawn.

Presentational conventions

The terms in this PAS are arranged by topic and an index is provided so the location of each term can be identified easily.

When the terms defined in this PAS are used in the definition or notes of another term, they are shown in bold type.

Contractual and legal considerations

This PAS does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with this PAS does not of itself confer immunity from legal obligations.

Introduction

The first edition of this PAS was commissioned by the UK Department of Trade and Industry in 2004 for the purposes of developing and encouraging the use of a common language relevant to the production, measurement and characterization of nanoparticles. The PAS was intended to seed further developments and discussions in formal standards-making and inform the production of other standards in the area.

Nanotechnologies are a group of emerging technologies, characterized by the production, manipulation, control and application of matter in the nanoscale in order to make use of size- and structure-dependent properties and phenomena, as distinct from those associated with individual atoms or molecules or with bulk materials. These technologies are developing quickly and will gain increasing importance over the next few years. Their application is expected to impact virtually all areas of human endeavour, in particular agriculture, construction, energy generation and storage, engineering, environmental remediation, ICT, medicine and medical devices, sustainability and transport.

This PAS was commissioned in response to demands by UK industry to provide standards to support future applications. The intention was to bring together the disparate terms and definitions relevant to the production, measurement and characterization of nanoparticles. The principal difference between a PAS and a full British, European or international standard, is that a PAS is created in a consultative process across industry rather than gaining the full consensus of a specific technical committee. This PAS will be withdrawn once equivalent full consensus international standards on the subject have been published. Until then, it will be updated where necessary to cover new developments in the field.

The remit of this PAS is to document and, to a lesser degree, comment on the current use of basic nanoparticle terms and definitions in use by manufacturers, suppliers, academia, regulators and governments and to make recommendations for usage as required. It also includes terms defining common production methods and analytical techniques employed by those working with nanoparticles.

Together with six related PAS vocabularies (see www.bsigroup.com/nano), PAS 71 has helped to stimulate international activity in the area being undertaken by a joint working group between ISO/TC 229, Nanotechnologies and IEC/TC 113, Nanotechnology standardization for electrical and electronic products and systems. This activity has led to the publication of three internationally accepted vocabularies to date, the output of which is reflected in this revision of PAS 71.

Following the introduction of the term “nano-object” in DD CEN ISO/TS 27687, which includes all objects with one, two or three dimensions in the nanoscale, and the redefinition of “nanoparticle” in the same document to cover only nano-objects with all three external dimensions in the nanoscale, consideration was given to revising this PAS to make it applicable to nano-objects rather than simply nanoparticles. However, it was agreed that this would have significant repercussions for the document and it was therefore decided to continue to focus it on nanoparticles, recognizing that this might limit its applicability. It was also recognized that some definitions would be more generally applicable to nano-objects.

This PAS does not provide a nomenclature systems for nanoparticles, as this is a specialized subject and there is no current consensus in the nanotechnologies or nanosciences communities on how to approach such a system. However, work has commenced in ISO/TC 229 on developing a framework for nomenclature models for nano-objects.

1 Scope

This PAS defines terms in use in the field of nanoparticles. It is intended to facilitate communications between organizations and individuals in industry and research and those who interact with them. It does not include a nomenclature system for nanoparticles.

NOTE A list of abbreviations used in this PAS is given in Annex A.

2 General

2.1 nanofibre

nano-object with two similar external dimensions in the **nanoscale** and the third 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 larger external dimension is not necessarily in the **nanoscale**.

[DD CEN ISO/TS 27687:2009, 4.3]

2.2 nanomaterial

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

NOTE 1 This generic term is inclusive of **nano-object** and **nanostuctured material**.

NOTE 2 See also **engineered nanomaterial**, **manufactured nanomaterial** and **incidental nanomaterial**.

[DD ISO/TS 80004-1:2010, 2.4]

2.2.1 engineered nanomaterial

nanomaterial designed for a specific purpose or function

[DD ISO/TS 80004-1:2010, 2.8]

2.2.2 incidental nanomaterial

nanomaterial generated as an unintentional by-product of a process

NOTE 1 The process includes manufacturing, bio-technological or other processes.

NOTE 2 See PD ISO/TR 27628:2007, 2.21 for a definition of ultrafine particle.

[DD ISO/TS 80004-1:2010, 2.10]

2.2.3 manufactured nanomaterial

nanomaterial intentionally produced for commercial purpose to have specific properties or specific composition

[DD ISO/TS 80004-1:2010, 2.9]

2.3 nano-object

material with one, two or three external dimensions in the **nanoscale**

*NOTE Generic term for all discrete **nanoscale** objects.*

[DD ISO/TS 80004-1:2010, 2.5]

2.4 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 **nanorod** or **nanoplate** are intended to be used instead of the term **nanoparticle**.*

[DD CEN ISO/TS 27687:2009, 4.1]

2.5 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**.*

[DD CEN ISO/TS 27687:2009, 4.2]

2.6 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.*

[DD ISO/TS 80004-1:2010, 2.1]

2.7 nanoscience

study, discovery and understanding of matter in the **nanoscale**, where size- and structure-dependent properties and phenomena, as distinct from those associated with individual atoms or molecules or with bulk materials, can emerge

[DD ISO/TS 80004-1:2010, 2.2]

2.8 nanostructure

composition of inter-related constituent parts, in which one or more of those parts is a **nanoscale** region

NOTE A region is defined by a boundary representing a discontinuity in properties.

[DD ISO/TS 80004-1:2010, 2.6]

2.9 nanostructured material

material having internal **nanostructure** or surface **nanostructure**

*NOTE This definition does not exclude the possibility for a **nano-object** to have internal structure or surface structure. If external dimension(s) are in the **nanoscale**, the term **nano-object** is recommended.*

[DD ISO/TS 80004-1:2010, 2.7]

2.10 nanotechnology

application of scientific knowledge to manipulate and control matter in the **nanoscale** in order to make use of size- and structure-dependent properties and phenomena distinct from those associated with individual atoms or molecules or with bulk materials

NOTE Manipulate and control includes material synthesis.

[DD ISO/TS 80004-1:2010, 2.3]

3 Generic particles

NOTE All of the particles listed in this clause can be **nanoparticles** under certain conditions.

3.1 agglomerate

collection of weakly bound particles or **aggregates** or mixtures of the two where the resulting external surface area is similar to the sum of the surface areas of the individual components

NOTE 1 The forces holding an agglomerate together are weak forces, for example van der Waals forces, or simple physical entanglement.

NOTE 2 Agglomerates are also termed secondary particles and the original source particles are termed **primary particles**.

[DD CEN ISO/TS 27687:2009, 3.2]

3.2 aggregate

particle comprising strongly bonded or fused particles where the resulting external surface area may be significantly smaller than the sum of calculated surface areas of the individual components

NOTE 1 The forces holding an aggregate together are strong forces, for example covalent bonds, or those resulting from sintering or complex physical entanglement.

NOTE 2 Aggregates are also termed secondary particles and the original source particles are termed **primary particles**.

[DD CEN ISO/TS 27687:2009, 3.3]

3.3 dendrimer

repeatedly branched **macromolecule**

NOTE Dendrimers can be configured as a sphere, partial sphere or wedge structure (i.e. dendritic wedge).

[PAS 136:2007, 5.2]

3.4 dendritic particle

particle with a highly branched structure

NOTE Also referred to as a branched-chain **aggregate**.

3.5 engineered nanoparticle

nanoparticle designed for specific purpose or function

NOTE See **engineered nanomaterial**.

3.6 floc

<in a liquid> assemblage of particles, which, having been initially dispersed, have become loosely coherent

NOTE Also referred to as **flocc** and **flocculate**.

[BS 2955:1993, 1.18]

3.7 fume

cloud of airborne particles arising from condensation of vapours from either chemical or physical reactions

*NOTE A fume can be made of **nanoparticles** of low volatility.*

[derived from BS 2955:1993, 1.20]

3.8 fumed powder

powder recovered from a **fume**

[BS 2955:1993, 2.11]

3.9 incidental nanoparticle

nanoparticle generated as an unintentional by-product of a process

*NOTE See **incidental nanomaterial**.*

3.10 macromolecule

molecule with high relative molecular mass comprising multiple repetitive units derived from molecules of lower relative molecular mass

[PAS 136:2007, 5.4]

3.11 manufactured nanoparticle

nanoparticle intentionally produced for commercial purpose to have specific properties or specific composition

*NOTE See **manufactured nanomaterial**.*

3.12 milled powder

powder produced by **comminution** in a mill

[BS 2955:1993, 2.14]

3.13 nanocore

encapsulated part of a **nanoparticle** where the encapsulating material is different from the core material

3.14 nanocrystal

nanoscale solid formed with a periodic lattice of atoms, ions or molecules

3.15 nano-onion

spherical **nanoparticle** with concentric multiple shell structure

[DD ISO/TS 80004-3:2010, 2.8]

3.16 nanopowder

collection of dry **nano-objects**

3.17 nanoribbon

nanoplate with one of its two larger dimensions in the **nanoscale** and the other significantly larger

[DD ISO/TS 80004-3:2010, 2.10]

3.18 nanorod

rigid **nanofibre**

[derived from DD CEN ISO/TS 27687:2009, 4.5]

3.19 nanorope

nanofibres in a twisted conformation

3.20 nanotube

hollow **nanofibre**

[DD CEN ISO/TS 27687:2009, 4.4]