



Designation: E2456 – 06

Standard Terminology Relating to Nanotechnology¹

This standard is issued under the fixed designation E2456; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 Nanotechnology is an emerging field; this standard defines the novel terminology developed for its broad multi- and interdisciplinary activities. As the needs of this area develop, this standard will evolve accordingly. Its content may be referenced and/or adopted, in whole or in part, as demanded by the needs of the individual user.

2. Referenced Documents

2.1 *ASTM Standards*:²

E1964 Practice for Compiling and Writing & Terminology (Withdrawn 2007)³

E1992 Terminology Relating to Terminology Management (Withdrawn 2007)³

3. Significance and Use

3.1 This standard is intended to facilitate communication among members of the business, research, legal, government, and educational communities.

3.2 Definitions:

3.2.1 Terms and their related standard definitions in Section 4 are intended for use uniformly and consistently in all nanotechnology test methods, specifications, guides, and practices. The purpose of such use is to promote a clear understanding and interpretation of the standards in which they are used.

3.2.2 Definitions of terms are written in the broadest sense possible, consistent with the intended meaning using the following guidance considerations.

3.2.2.1 Terminology E1992 and Practice E1964 concepts are considered, especially Sections 6.5, 7, and 8 of Practice E1964.

3.2.2.2 Terms and nomenclature are based on observed scientific phenomena and are descriptive, distinguishable, and have significant currency in the nanotechnology field as reflected in peer-reviewed articles and other objective sources. These terms and names should not disrupt accepted usage in other scientific and technological fields, and their preferred usage should follow accepted scientific syntax.

3.2.2.3 When incorporating a term or name from a related field, its underlying meaning is not redefined. Modifications are minimal and are done to elucidate scientific distinctions required by nanotechnology practitioners.

3.2.2.4 When conflicting or overlapping terms and names arise between scientific disciplines, precedence was given to the established term that has behind it a significant body of knowledge.

3.2.2.5 The definition of a term that can have different meanings in different technical fields, especially those fields beyond nanotechnology, is preceded by a limiting phrase, for example, “*in nanotechnology*.”

3.3 Description of Terms:

3.3.1 Descriptions of Terms are special purpose definitions intended to provide a precise understanding and interpretation of standards in which they are used.

3.3.2 A specific description of a term is applicable to the standard or standards in which the term is described and used.

3.3.3 Each standard in which a term is used in a specially defined manner beyond the definitions in Section 3 should list the term and its description under the subheading, descriptions of terms.

3.3.4 Practice E1964, Section 13, are used to guide the contents of descriptions.

3.3.5 As nanotechnology is a rapidly developing field, it will be necessary to continually reassess the terms and definitions contained in this standard, for purposes of revision when necessary. The intent of the terms and definitions in this standard is to describe materials containing features between approximately 1 and 100 nm and to differentiate those properties different from properties found in either molecules or the bulk (interior) of larger, micron-sized systems.

3.4 Discussion of Terms:

3.4.1 Discussion sub-paragraphs are non-normative. They are used in this standard to provide explanatory information, to clarify distinctions between the use of terms in this standard as

¹ This terminology is under the jurisdiction of ASTM Committee E56 on Nanotechnology and is the direct responsibility of Subcommittee E56.01 on Informatics and Terminology.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

compared with that in other contexts or other fields of technology and to suggest preferred usage of a term.

4. Terminology

agglomerate, *n*—*in nanotechnology*, a group of particles held together by relatively weak forces (for example, Van der Waals or capillary), that may break apart into smaller particles upon processing, for example.

aggregate, *n*—*in nanotechnology*, a discrete group of particles in which the various individual components are not easily broken apart, such as in the case of primary particles that are strongly bonded together (for example, fused, sintered, or metallically bonded particles).

fine particle, *n*—*in nanotechnology*, a particle smaller than about 2.5 micrometers and larger than about 0.1 micrometers in size.

DISCUSSION—Used in aerosols science to describe atmospheric aerosol involving particles that may be solids or liquids.

nano, *n*—(1) The SI definition, a prefix used to form decimal submultiples of the SI unit “meter”, designating a factor of 10^{-9} denoted by the symbol “n”. (2) Pertaining to things on a scale of approximately 1 to 100 nanometers (nm). (3) A prefix referring to an activity, material, process or device that pertains to a field of knowledge defined by nanotechnology and nanoscience.

nanoparticle, *n*—*in nanotechnology*, a sub-classification of ultrafine particle with lengths in two or three dimensions greater than 0.001 micrometer (1 nanometer) and smaller than about 0.1 micrometer (100 nanometers) and which may or may not exhibit a size-related intensive property.

DISCUSSION—This term is a subject of controversy regarding the size range and the presence of a size-related property. Current usage emphasizes size and not properties in the definition. The length scale may be a hydrodynamic diameter or a geometric length appropriate to the intended use of the nanoparticle.

nanoscale, *adj*—having one or more dimensions from approximately 1 to 100 nanometers (nm).

nanoscience, *n*—the study of nanoscale materials, processes, phenomena, or devices.

nanostructured, *adj*—containing physically or chemically distinguishable components, at least one of which is nanoscale in one or more dimensions.

DISCUSSION—While many conventional nanomaterials are distinguished by physical or chemical characteristics, biological recognition may also be the basis for defining a nanostructure. Though this concept is formally contained by the word ‘chemically’ such a feature would lead to a distinctive type of nanostructured system.

nanotechnology, *n*—A term referring to a wide range of technologies that measure, manipulate, or incorporate materials and/or features with at least one dimension between approximately 1 and 100 nanometers (nm). Such applications exploit the properties, distinct from bulk/macroscale systems, of nanoscale components.

non-transitive nanoparticle, *n*—*in nanotechnology*, a nanoparticle that does not exhibit size-related intensive properties.

DISCUSSION—This term should be used when the subject material has stable properties that fall on a continuum that can be smoothly extrapolated from the behavior of the bulk (larger scale) material. Non-transitive nanoparticles are often applied in industries that exploit their features, such as minimal optical scattering or high surface areas, to improve the radiation absorption, abrasion resistance or mechanical strength of materials.

particle, *n*—*in nanotechnology*, a small object that behaves as a whole unit in terms of its transport and properties.

transitive nanoparticle, *n*—*in nanotechnology*, a nanoparticle exhibiting a size-related intensive property that differs significantly from that observed in fine particles or bulk materials.

DISCUSSION—This term should be used when the material has properties that emerge only on the nanoscale. It is reserved for the special case of nanoscale materials which have behavior that does not smoothly or simply extrapolate from the bulk, and also encompasses those systems which have features that respond to external forces in an interactive manner.

ultrafine particle, *n*—*in nanotechnology*, a particle ranging in size from approximately 0.1 micrometer (100 nanometers) to .001 micrometers (1 nanometer).

DISCUSSION—The term is most often used to describe aerosol particles such as those found in welding fumes and combustion by-products. The length scale may be measured by a particle’s geometric, aerodynamic, mobility, projected-area, or hydrodynamic dimension.