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Standard Guide for Reporting the Physical and Chemical Characteristics of Nano-Objects¹

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1. Scope

1.1 This guide provides guidelines for a description system for reporting the physical and chemical characteristics of individual nano-objects. It establishes information categories and descriptors useful in describing individual nano-objects uniquely and such that the equivalency of two or more individual nano-objects can be determined according to specific criteria.

1.2 This guide is designed to be directly applicable to reporting the physical and chemical characteristics of nano-objects in every circumstance, including but not limited to reporting original research results in the archival literature, developing ontologies, database schemas, data repositories, and data reporting formats, specifying regulations, and enabling commercial activity.

1.3 This guide is applicable to naturally-occurring, engineered, and manufactured nano-objects.

1.4 One goal of the guide is to help ensure that when measurement results are reported, they are reported uniformly.

1.5 A second goal of the guide is to encourage reports on the properties and functionalities of a nano-object to include as much detail as possible about the physical and chemical characteristics of that nano-object so it is uniquely specified.

1.6 This guide does not cover the chemical reactions or reactivity of a nano-object.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

¹ This guide 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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1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

D16 Terminology for Paint, Related Coatings, Materials, and Applications

E3172 Guide for Reporting Production Information and Data for Nano-Objects

2.2 ISO Standards:³

ISO/TS 12805:2011(en) Nanotechnologies – Materials Specifications – Guidance on Specifying Nano-Objects

ISO/TS 18158:2016(en) Workplace Air – Terminology

ISO/TS 20787:2017(en) Nanotechnologies – Aquatic Toxicity Assessment of Manufactured Nanomaterials in Saltwater Lakes using *Artemia sp. Nauplii*

ISO/TS 27687:2008(en) Nanotechnologies – Terminology and Definitions for Nano-Objects – Nanoparticle, Nanofibre and Nanoplate

ISO/TS 80004-1:2015(en) Nanotechnologies – Vocabulary – Part 1: Core Terms

ISO/TS 80004-3:2015(en) Nanotechnologies – Vocabulary – Part 3: Carbon Nano-Objects

2.3 Other Documents:

The Uniform Description System for Materials on the Nanoscale CODATA-VAMAS Working Group on the Description of Nanomaterials, as released on 25 May 2016⁴

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 Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁴ Available from Committee on Data (CODATA) International Science Council, 5 rue Auguste Vacquerie, 75016 Paris, France, <https://www.codata.org/nanomaterials>.

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this document, see *ASTM Online Terminology Dictionary of Engineering Science and Technology*.⁵

3.2 Data Description Definitions:

3.2.1 *descriptor, n*—numerical data or text that expresses the measurement, observation, or calculational result of some aspect of an object.

3.2.1.1 *Discussion*—A descriptor conveys both the semantics of the results as well as the result itself.

3.2.2 *information category, n*—a set or group of related descriptors that represent a property, characteristic, interaction, performance, or other feature of an object.

3.2.2.1 *Discussion*—Information categories may be hierarchical and contain subcategories (referred to as such), each containing a set of descriptors.

3.2.2.2 *Discussion*—Information categories and their subcategories are constructed to convey understanding of the structure, properties, features, and performance of an object.

3.2.2.3 *Discussion*—A descriptor may occur in more than one information category.

3.2.2.4 *Discussion*—It is the responsibility of the owner of data or information resources using an information category to ensure that data and information redundancy is adequately addressed.

3.3 Nanomaterials Terminology:

3.3.1 *chemical moiety, n*—an identifiable part of a molecule that can act as a unit in chemical reactions.

3.3.1.1 *Discussion*—A moiety does not have to be able to exist separate from its inclusion in a molecule.

3.3.1.2 *Discussion*—A functional group is an example of a moiety, for example, the —COOH organic acid functional group.

3.3.2 *engineered nanomaterial, n*—nanomaterial designed for specific purpose or function.

ISO/TS 80004-1:2015(en), 2.8

3.3.3 *equivalency, n*—the ability of a description system to establish that two objects as assessed by different disciplines or user communities are the same according to specified criteria.

3.3.3.1 *Discussion*—In this guide, equivalency is the ability to establish that two nano-objects are the same according to specified criteria.

3.3.4 *manufactured nanomaterial, n*—nanomaterial intentionally produced to have selected properties or composition.

ISO/TS 80004-1:2015(en), 2.9

3.3.4.1 *Discussion*—Intentionally produced includes chemical, mechanical, electrical, nuclear, and other activities planned or controlled by humans.

3.3.5 *nanomaterial, n*—material with any external dimension in the nanoscale or having internal structure or surface structure in the nanoscale. **ISO/TS 80004-1:2015(en), 2.4**

3.3.6 *nano-object, n*—discrete piece of material with one, two or three external dimensions in the nanoscale.

ISO/TS 80004-1:2015(en), 2.10

3.3.6.1 *Discussion*—The second and third external dimensions are orthogonal to the first dimension and to each other.

ISO/TS 80004-1:2015(en), 2.5

3.3.6.2 *Discussion*—A nano-object is the smallest unit of nanomaterial that exists as a separate functional entity.

3.3.6.3 *Discussion*—A multilayer structure that is the smallest unit of nanomaterial with a specific functionality is defined herein to be a nano-object (see 3.3.5).

3.3.7 *nano-object feature, n*—a distinctive aspect of a nano-object.

3.3.7.1 *Discussion*—A nano-object feature can occur anywhere within or upon the nano-object.

3.3.7.2 *Discussion*—Within this guide, the term *nano-object feature* is sometimes referred to simply as a *feature*.

3.3.8 *naturally-occurring nanomaterial, n*—a nanomaterial made exclusively by natural processes.

3.3.8.1 *Discussion*—A naturally-occurring nanomaterial, when altered in any way by a process planned or controlled by humans, is, by definition, an engineered or manufactured nanomaterial.

3.3.8.2 *Discussion*—A nanomaterial produced by a natural process not planned or controlled by humans, for example, digestion or weathering of a rock, is naturally-occurring.

3.3.8.3 *Discussion*—There are instances when it is ambiguous or difficult to say whether a nanomaterial is naturally-occurring, engineered, or manufactured.

3.3.9 *uniquely, adv*—the quality of having uniqueness.

3.3.10 *uniqueness, n*—the ability of a description system to differentiate one nano-object from every other nano-object and to establish which specific nano-object is being described within the broad range of disciplines and user communities.

3.4 Shape Terminology:

3.4.1 *aspect ratio, n*—ratio of the extremal orthogonal dimensions of a nano-object.

3.4.1.1 *Discussion*—The aspect ratio reflects the fiber- or rod-like nature of a nano-object.

3.4.1.2 *Discussion*—The aspect ratio is sometimes called the sharpness of a nano-object.

3.4.1.3 *Discussion*—Aspect ratio applies to both two-dimensional and three-dimensional nano-objects.

3.4.2 *flatness, n*—ratio of the largest to smallest thickness for a two-dimensional-shaped nano-object.

3.4.2.1 *Discussion*—Flatness is sometimes referred to as thickness uniformity.

3.4.2.2 *Discussion*—This concept applies to both planar and non-planar shapes.

3.4.2.3 *Discussion*—See Fig. 3 and Fig. 4.

3.4.3 *sphericity, n*—ratio of the radii drawn from the geometric center of a nano-object to the closest and furthest surface features.

3.4.3.1 *Discussion*—Sphericity reflects how close a nano-object is to an ideal sphere; the closer the value is to 1, the more spherical is the nano-object.

⁵ *ASTM Online Terminology Dictionary of Engineering Science and Technology*, available from ASTM International, ASTM Stock Number: DEFONLINE.